

# Energy Research and Development Division

## FINAL PROJECT REPORT

# 21<sup>st</sup> CENTURY INSTREAM FLOW ASSESSMENT FRAMEWORK FOR MOUNTAIN STREAMS

## Appendices

Prepared for: California Energy Commission  
Prepared by: University of California, Davis  
Land, Air and Water Resources

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## PREFACE

The California Energy Commission Energy Research and Development Division supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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*21st Century instream flow assessment framework for mountain streams* is a report for contract number 500-02-004, conducted by the Center for Aquatic Biology at the University of California, Davis. The information from this project contributes to Energy Research and Development Division's Energy-Related Environmental Research Program.

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## ABSTRACT

Society expects that science and technology should play a central role in balancing hydropower societal benefits with preserving healthy aquatic ecosystems in remote mountainous regions. River science is relatively young and rapid advances in data-collection, mechanistic-modeling, and spatial-analysis technologies are transforming assessment methodologies and the state of knowledge. The disparity between the latest advances in scientific river research and the use of relatively simple river assessment methods for management efforts, such as hydropower dam relicensing, has been growing. This study addressed the gap by showing the practical capability and cost-effectiveness of performing instream flow assessment over a large spatial extent and at high resolution in a mountain river using a combination of remote-sensing methods and 2D hydrodynamic modeling. The authors conducted analyses that yielded an interdisciplinary and spatially explicit perspective on the status of a ~12.2 kilometer testbed river segment on the South Yuba River between Lake Spaulding and the town of Washington, CA in the northern Sierra Nevada. The researchers investigated stage-dependent patterns and processes at multiple spatial scales of fluvial landform nonuniformity. The most important finding was that the geomorphology, hydraulics, and physical habitat of the river segment are linked across four spatial scales. Researchers identified a recurring pattern of discrete fluvial landforms at the scale of ~1-10 channel widths in length. The study linked hydraulics and the availability of preferred physical microhabitat for specific fish species' lifestages to the observed pattern of morphological units, which were linked to reach attributes, which in turn were determined by segment-scale attributes. Perhaps the most important insight for river management was that integrating spatially explicit geomorphology, hydrology, hydraulics, and physical habitat characterization could improve instream flow assessment. Such integration would provide a foundation for quantifying current conditions, explaining their origins, and predicting what is necessary for their maintenance and/or improvement.

**Keywords:** instream flow assessment, mountain river hydraulics, mountain river fluvial geomorphology, mountain river hydrology, mountain river physical habitat analysis, regulated rivers, human impacts on rivers.

Please use the following citation for this report:

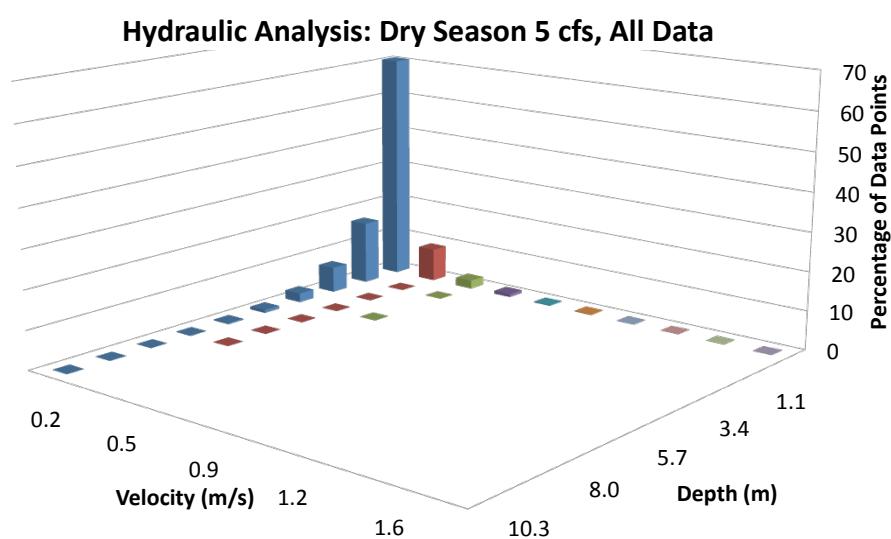
Pasternack, G.B. and A.E. Senter. 2011. *21st Century instream flow and assessment framework for maountain streams*. California Energy Commission, PIER. CEC-500-2013-059.

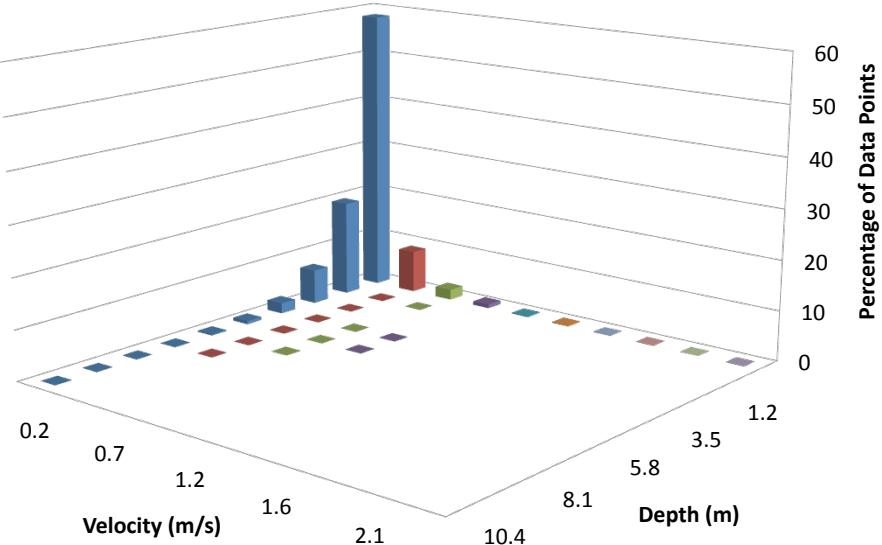
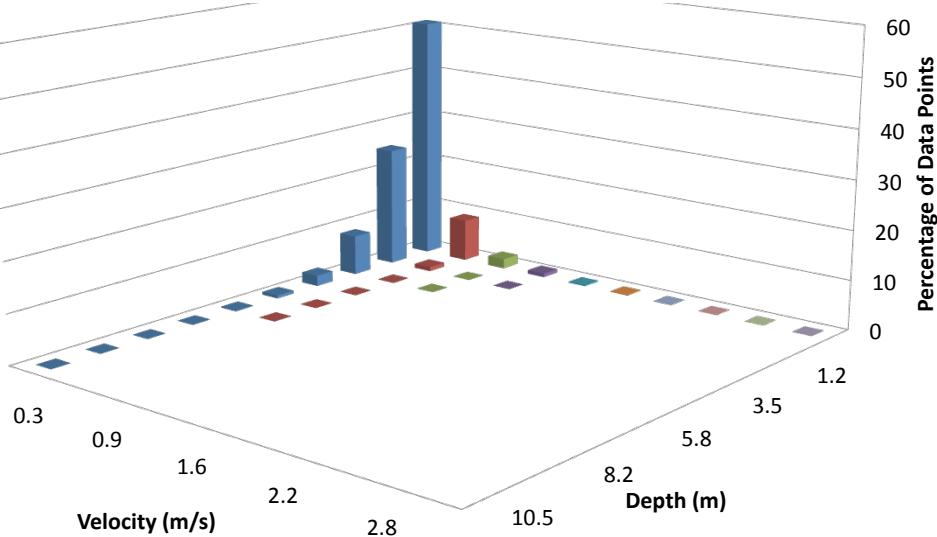
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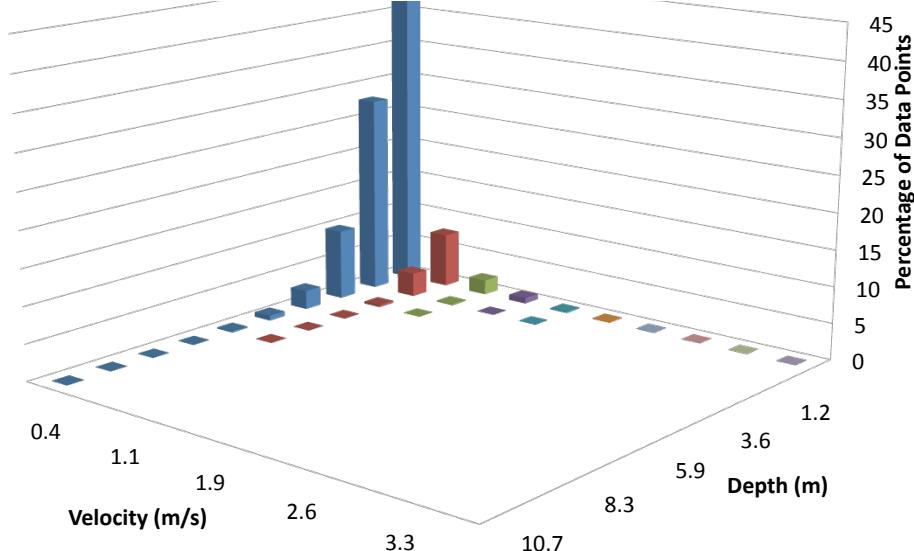
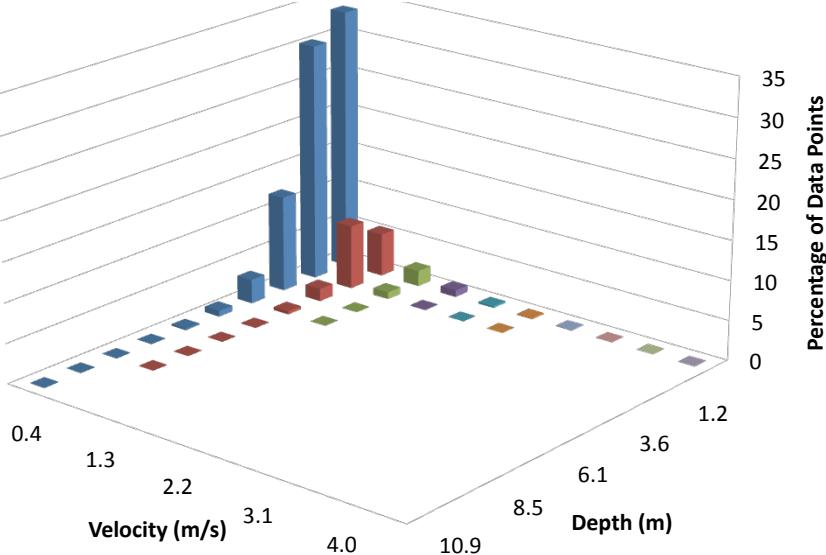
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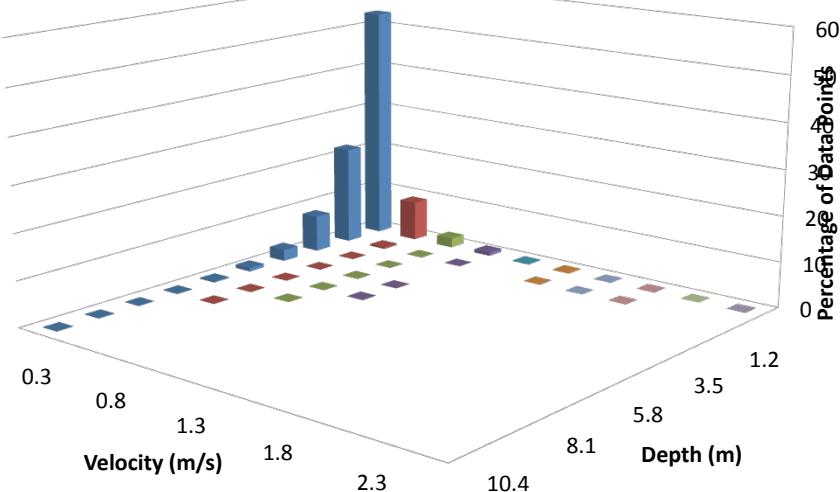
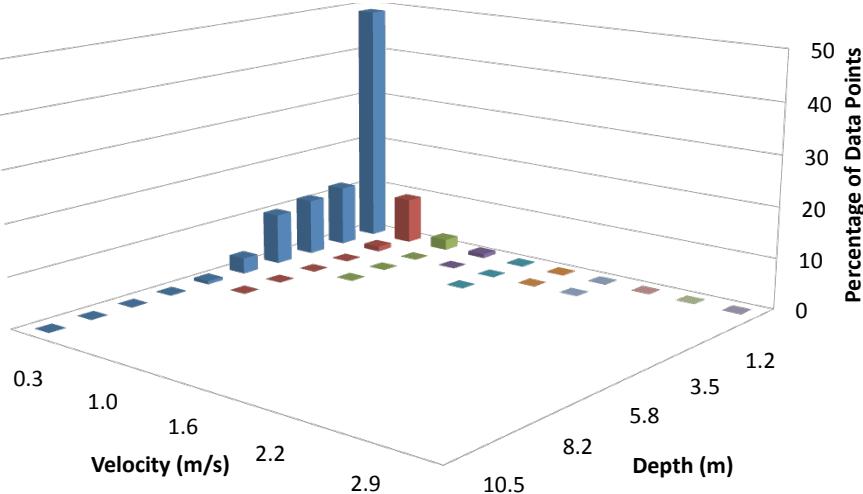
**APPENDIX A:**  
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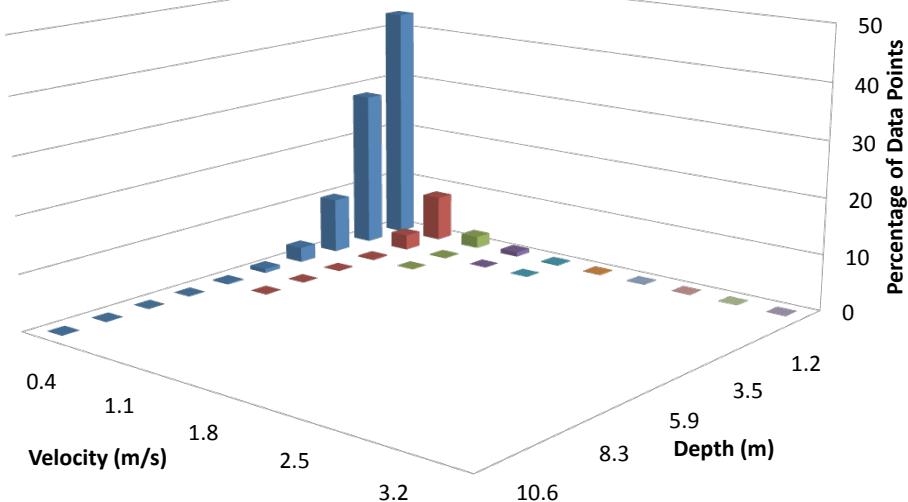
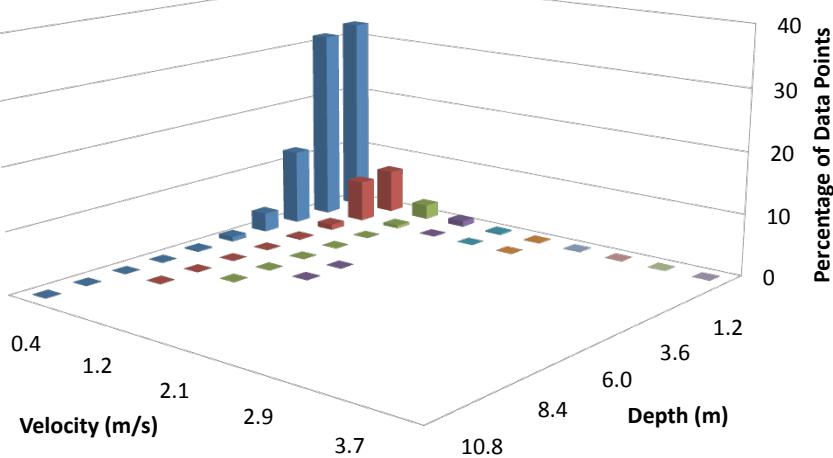
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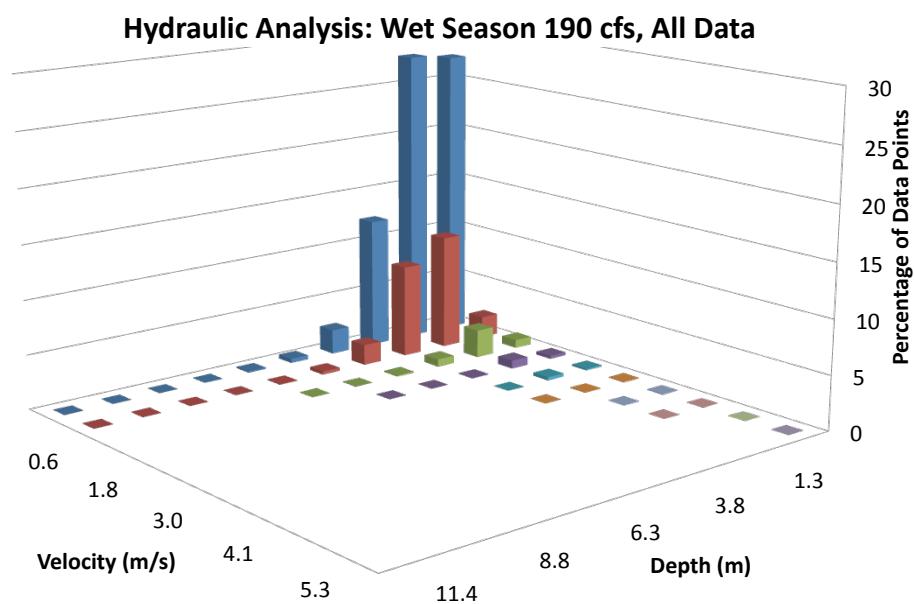
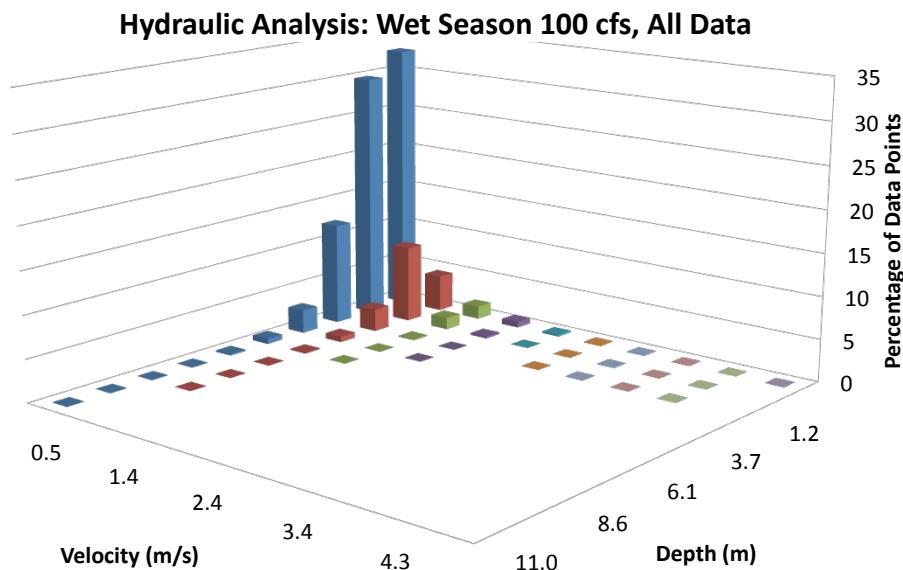


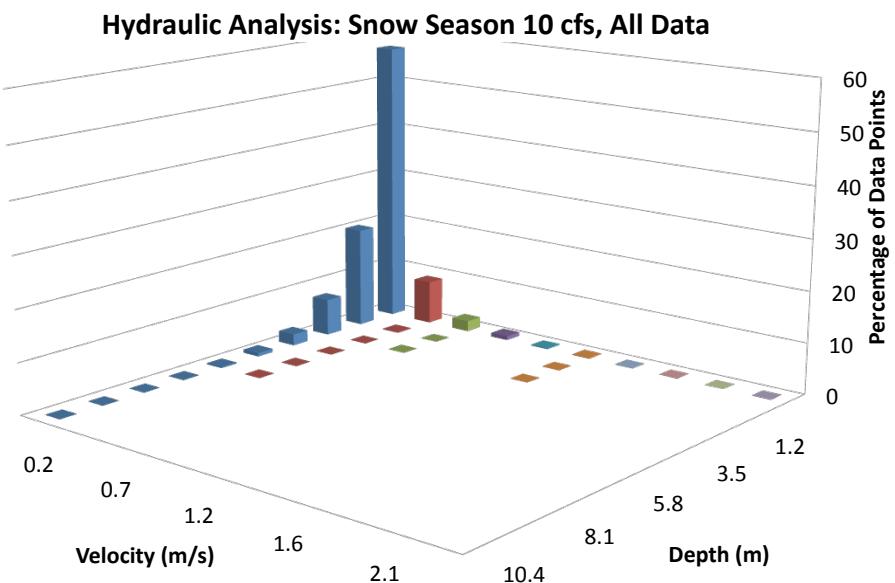
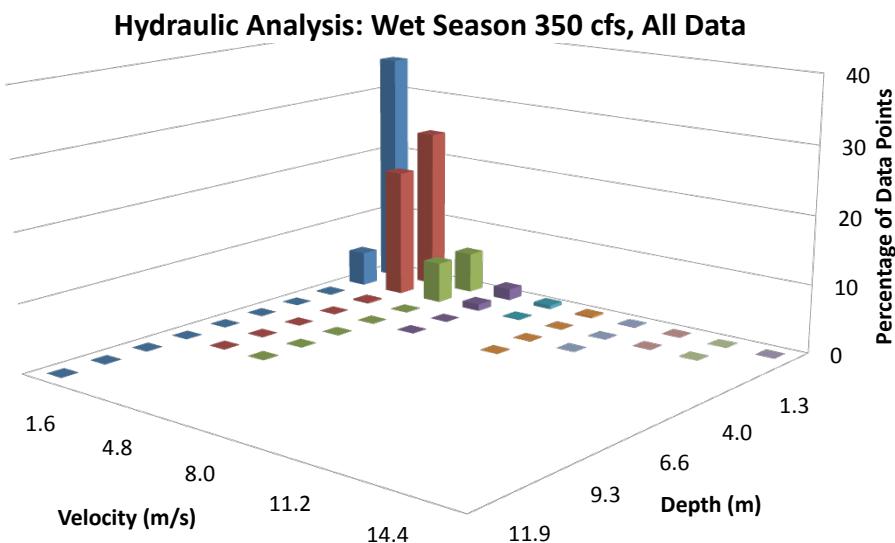
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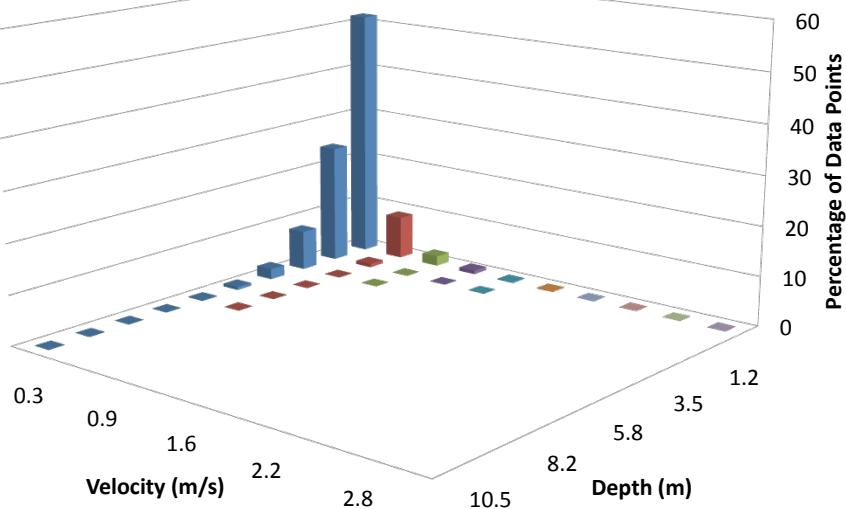
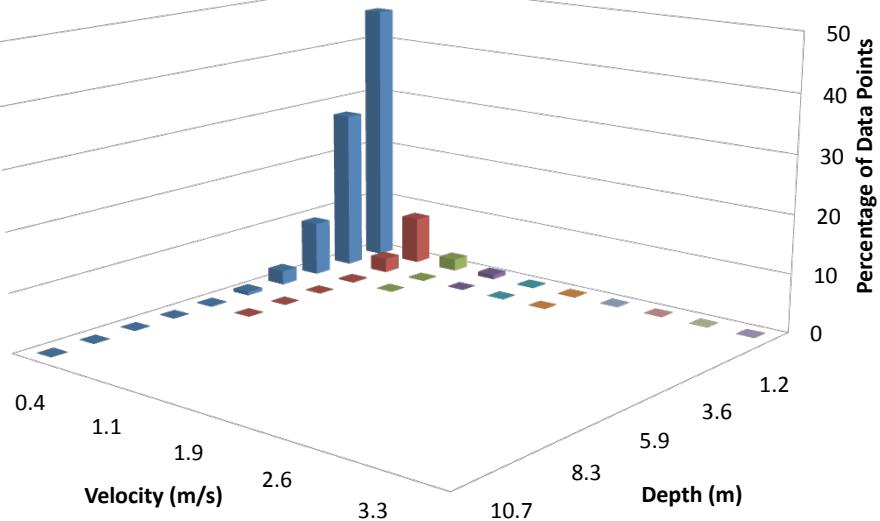
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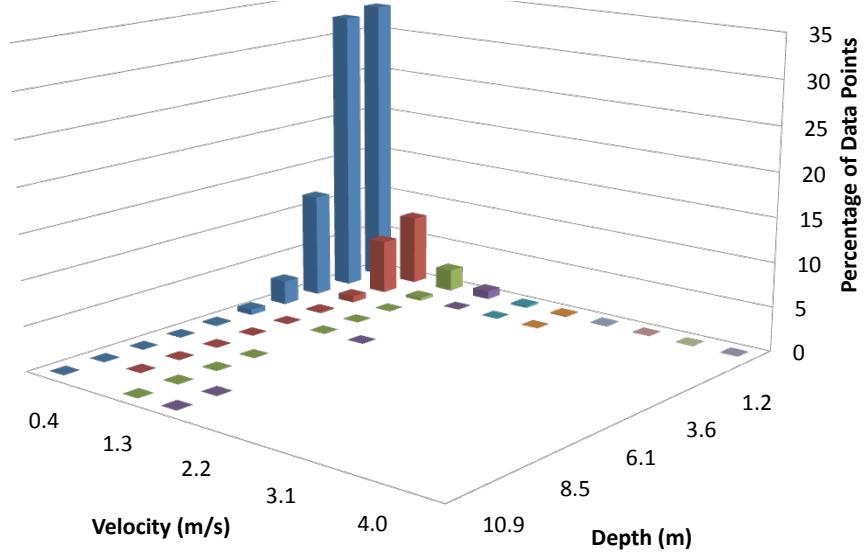
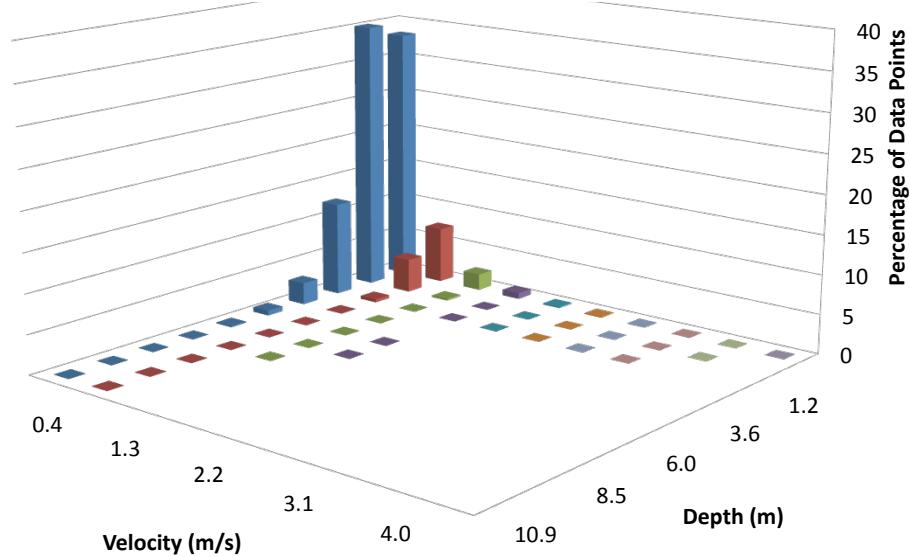
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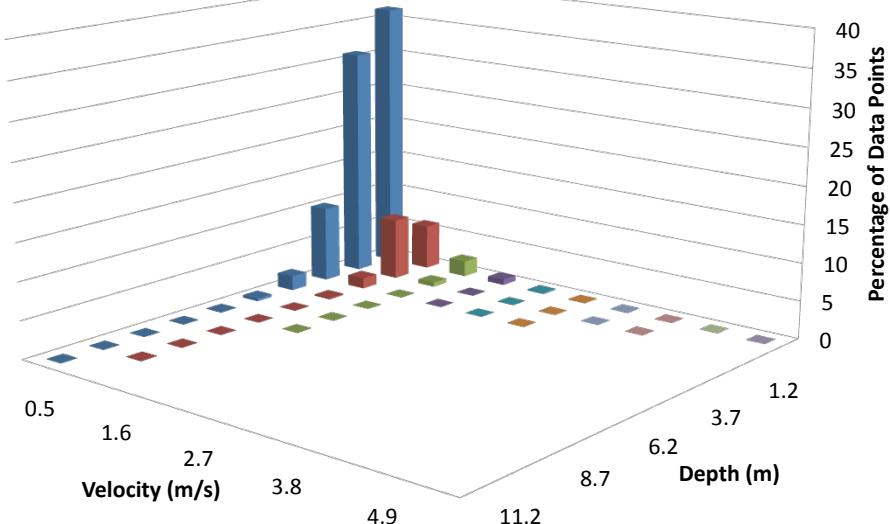
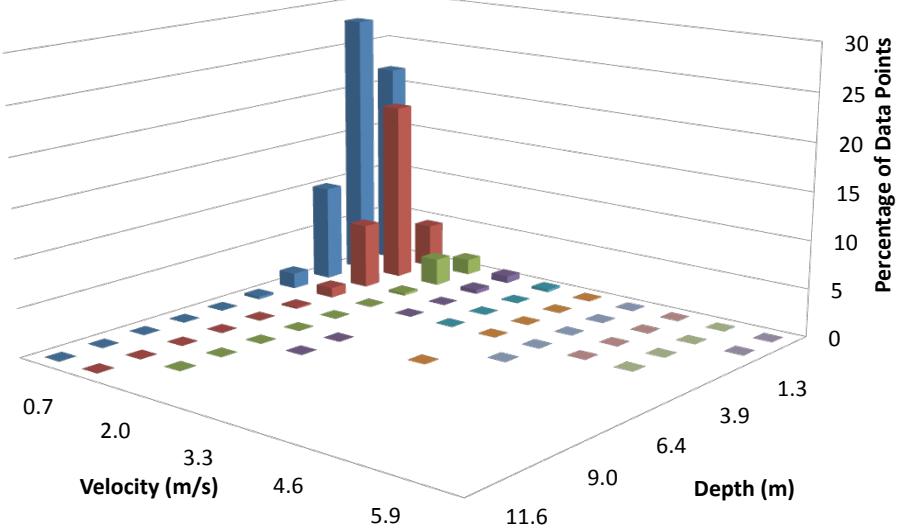
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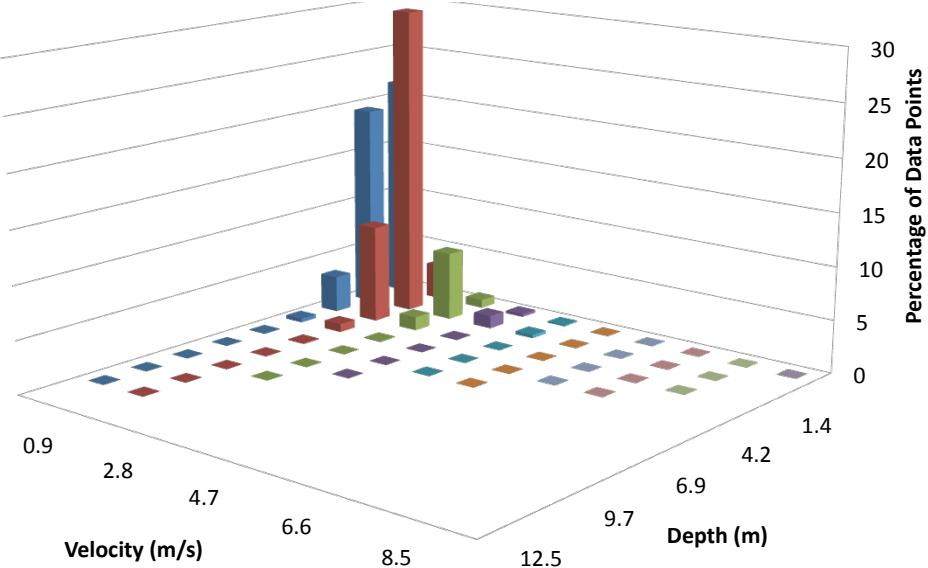
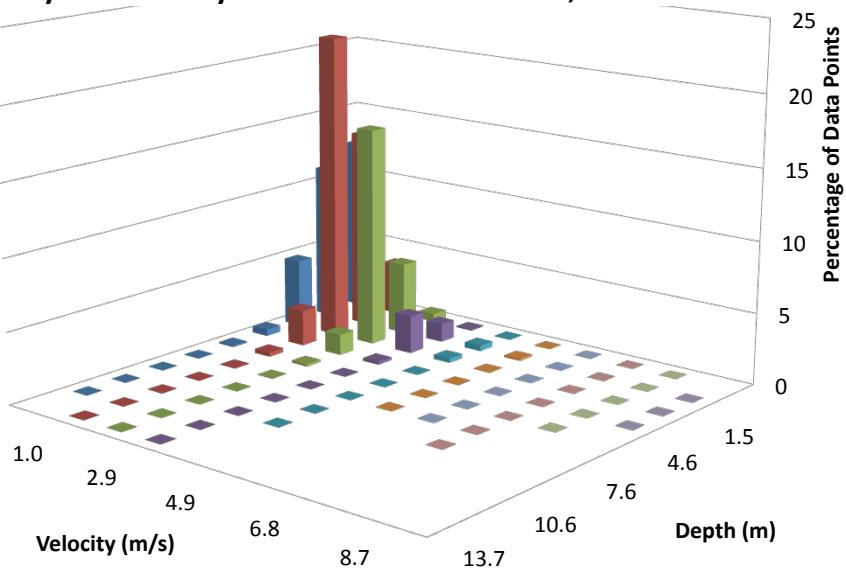




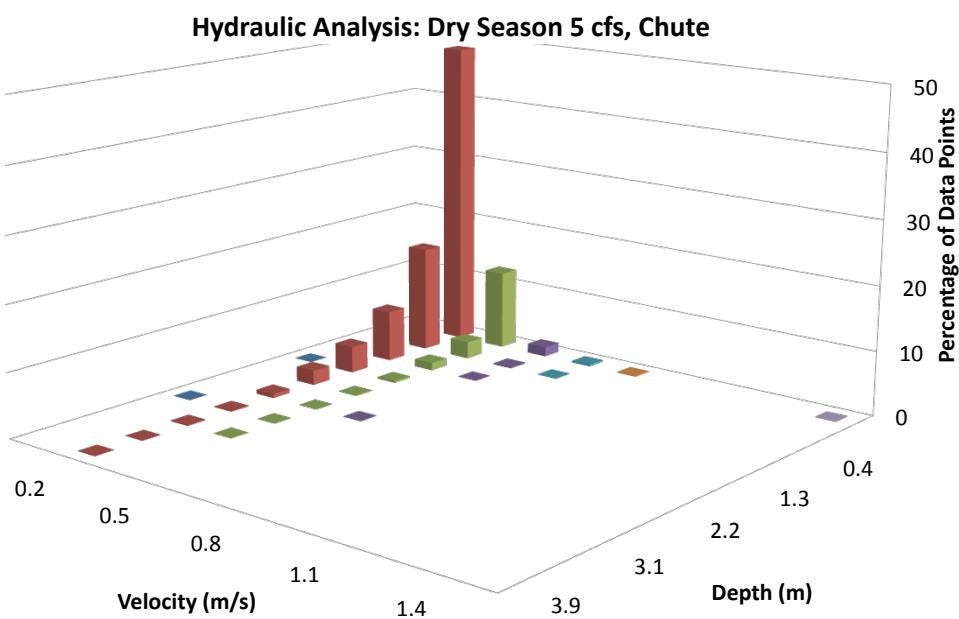
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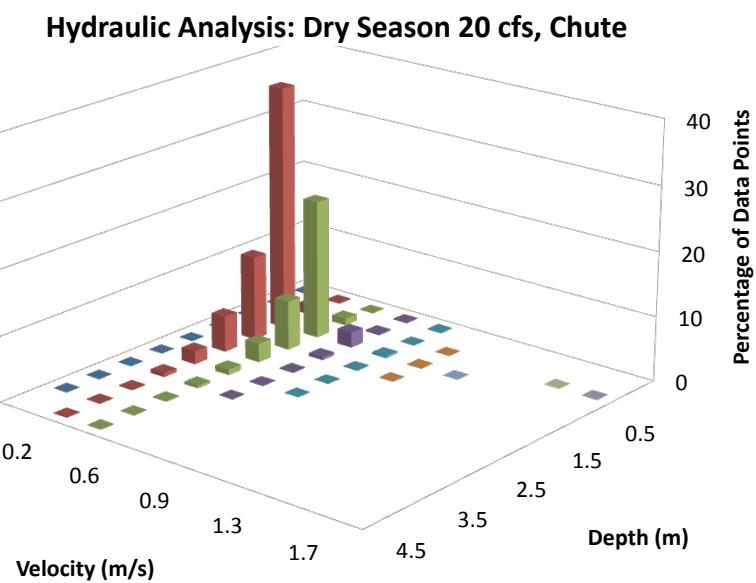
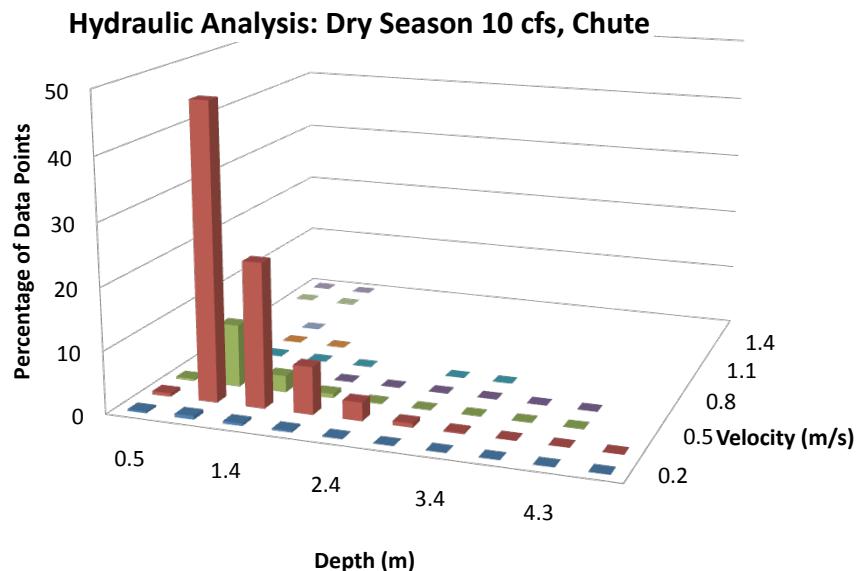
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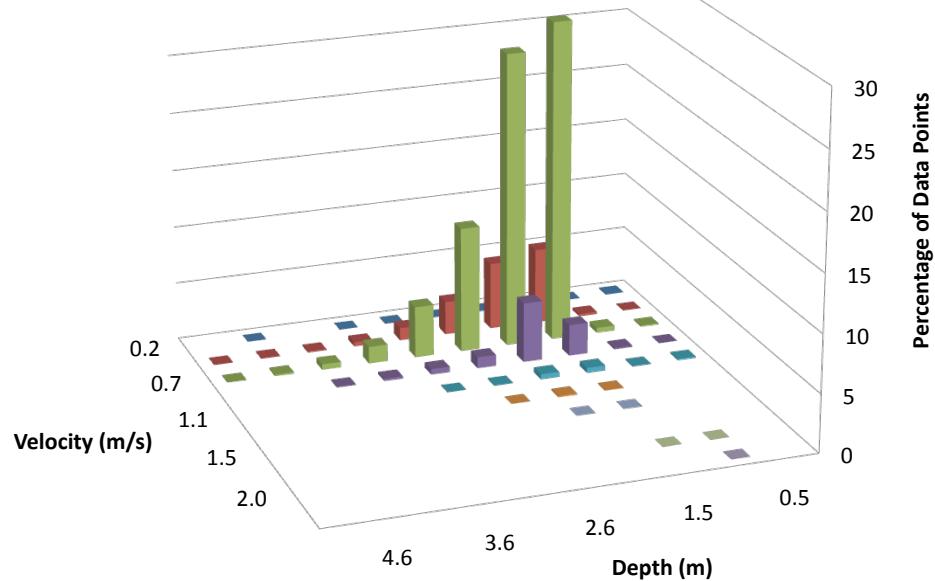
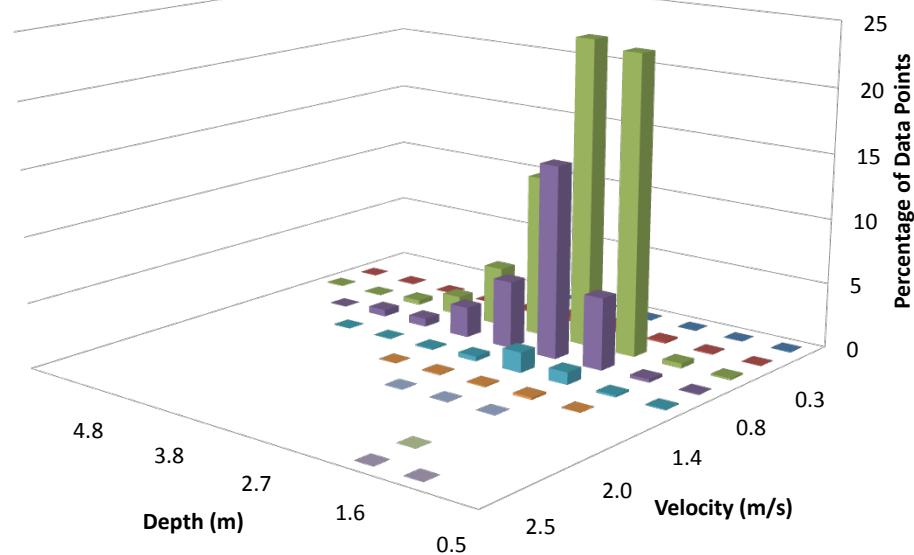
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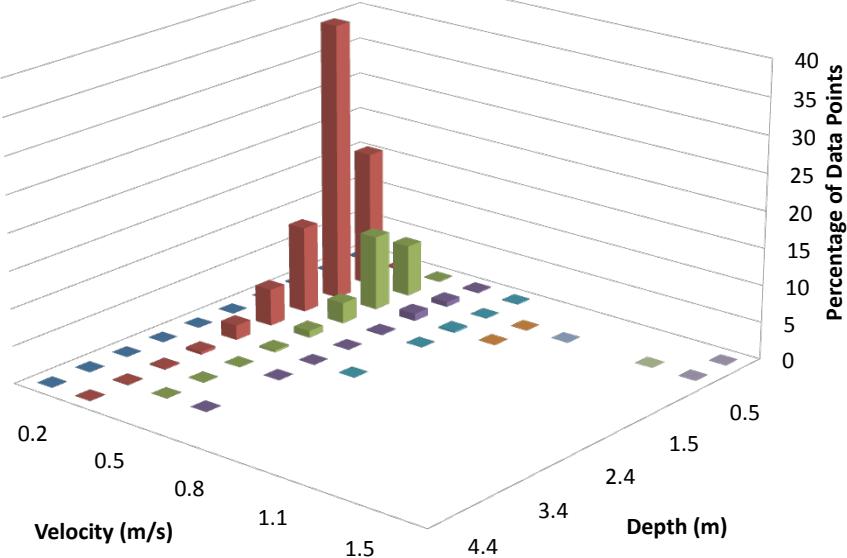
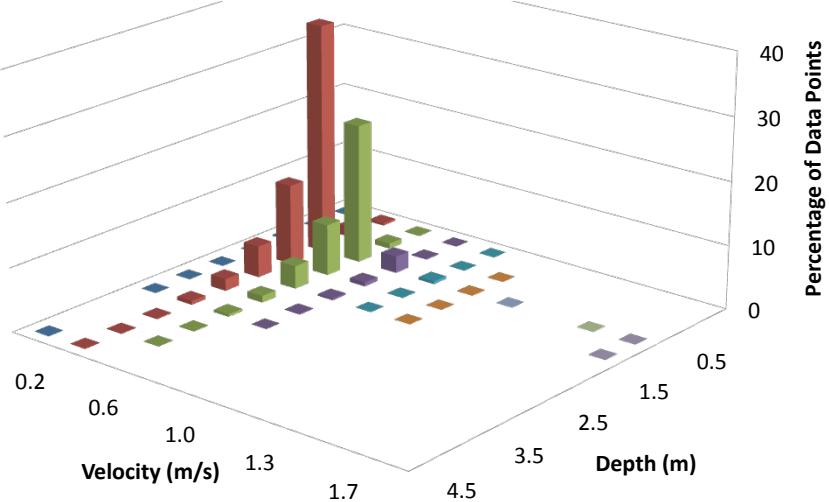
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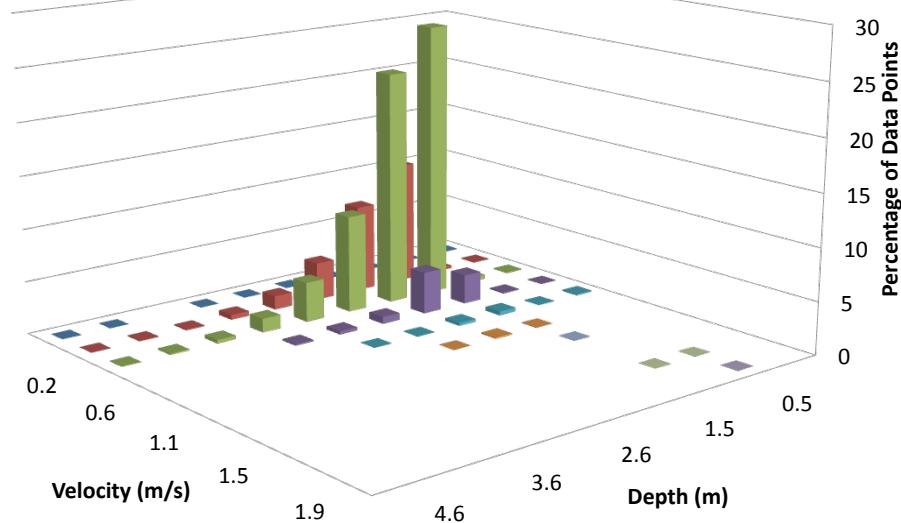
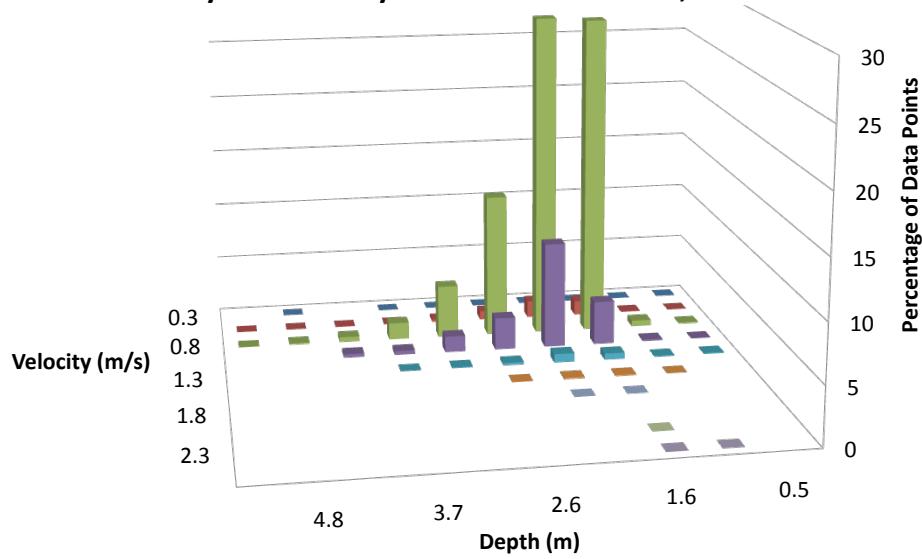
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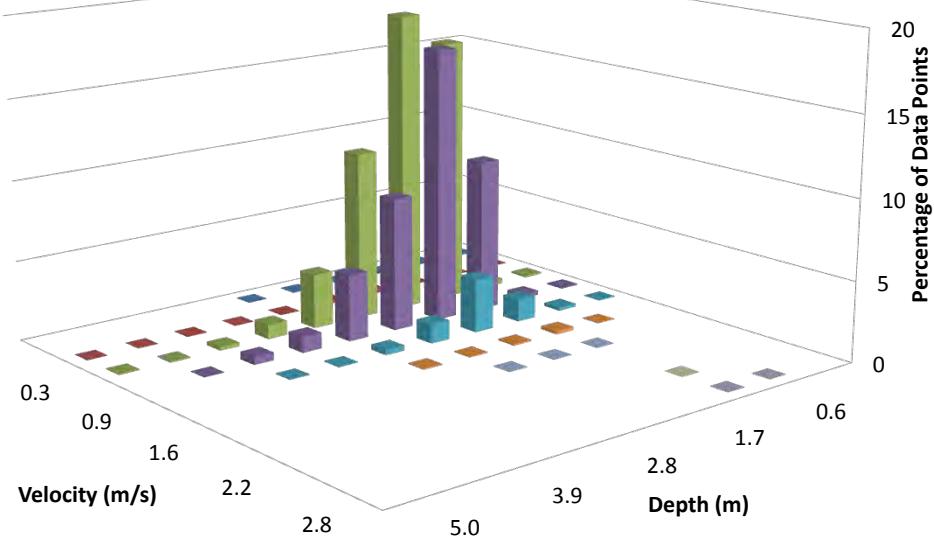
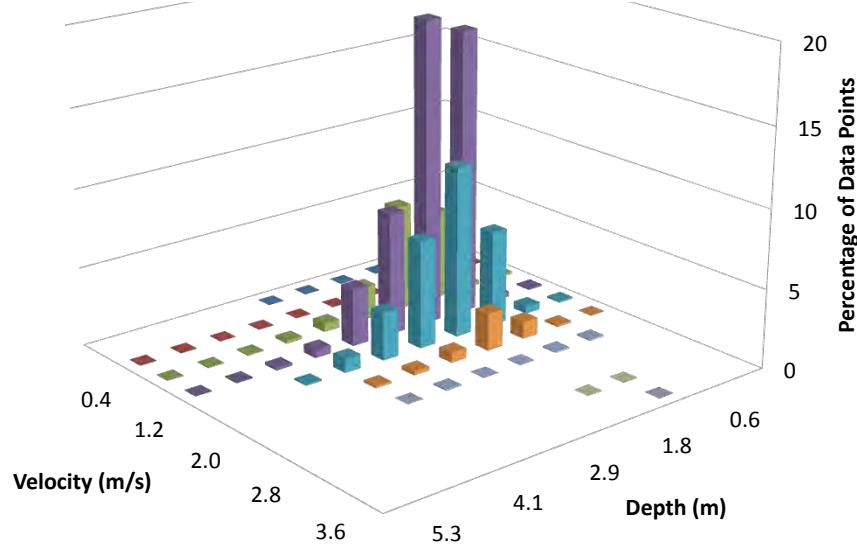


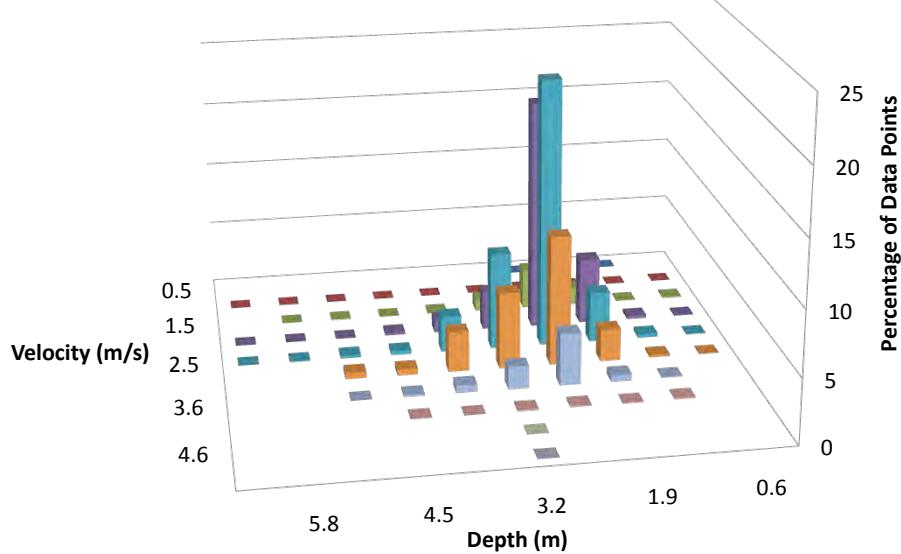
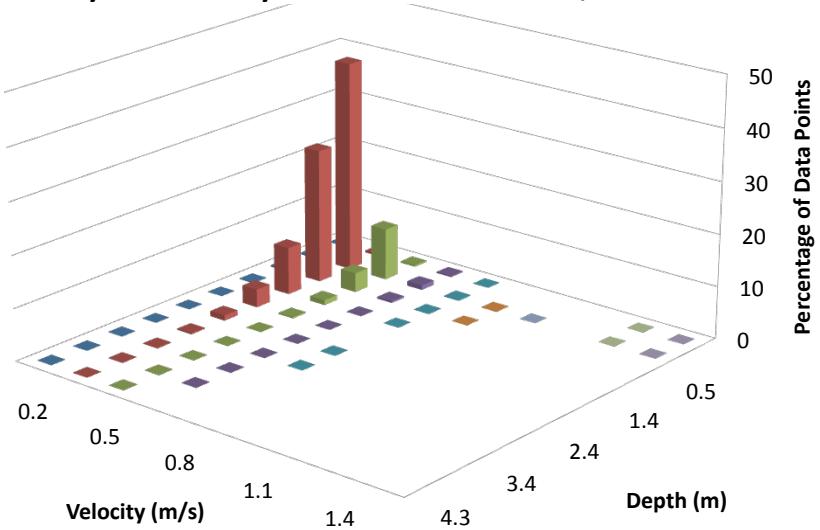


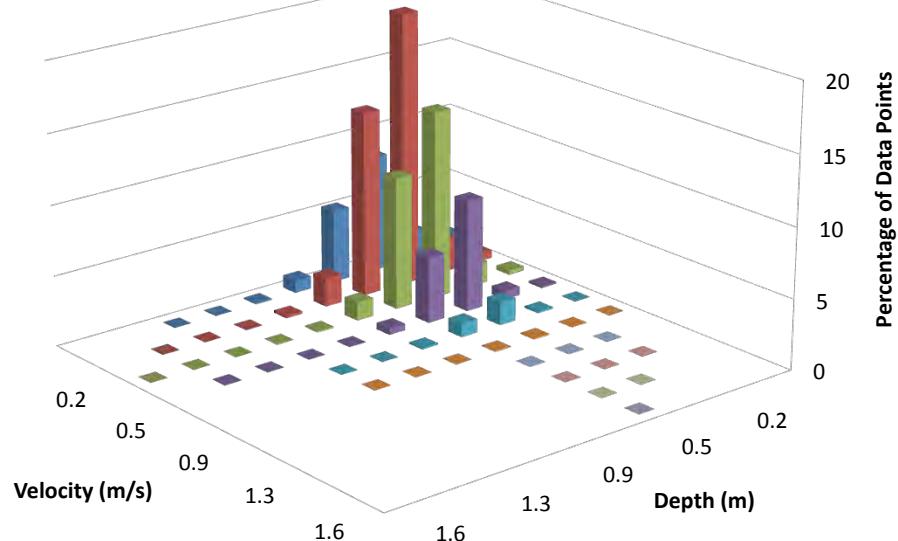
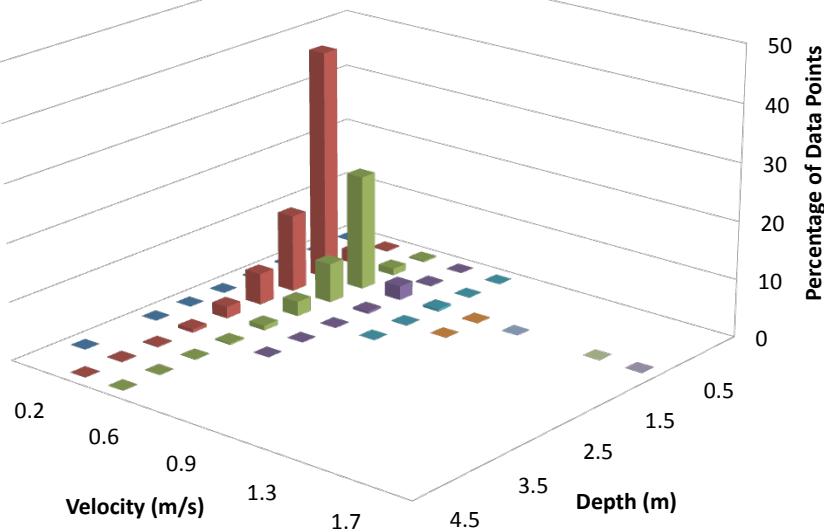
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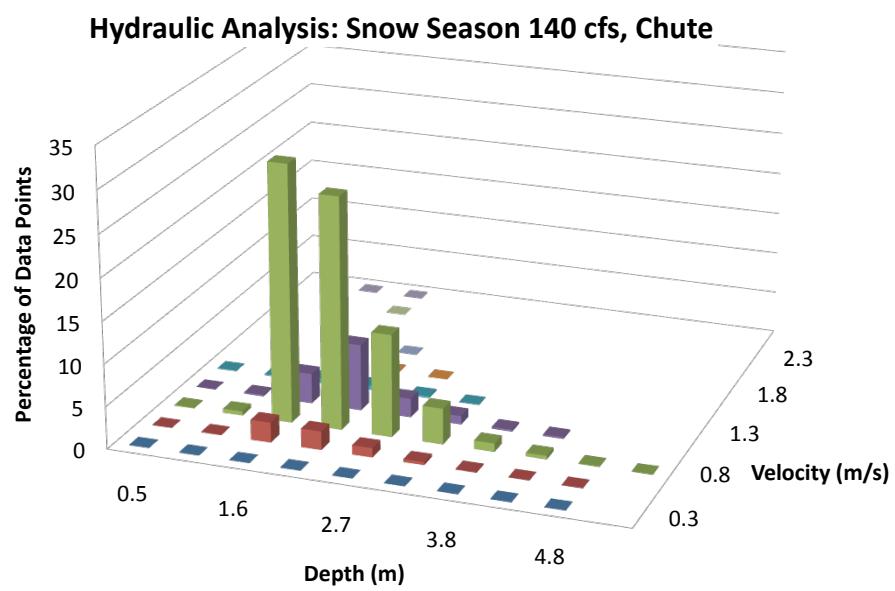
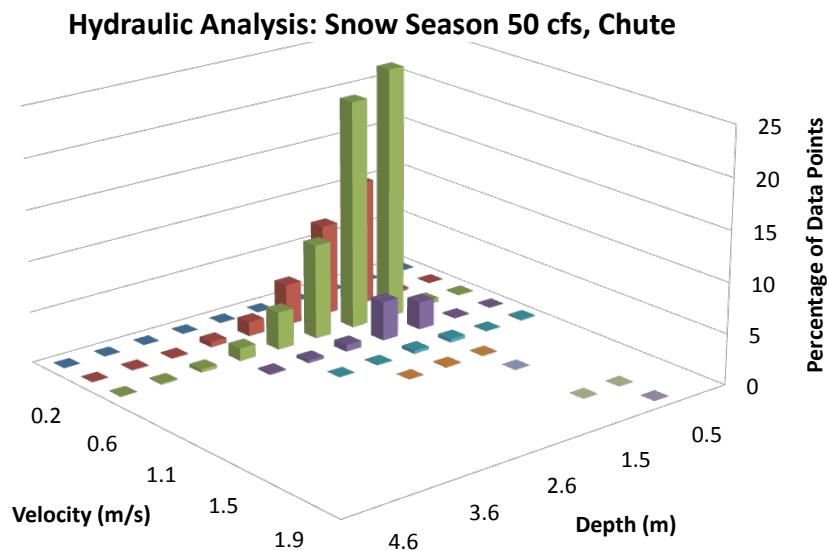
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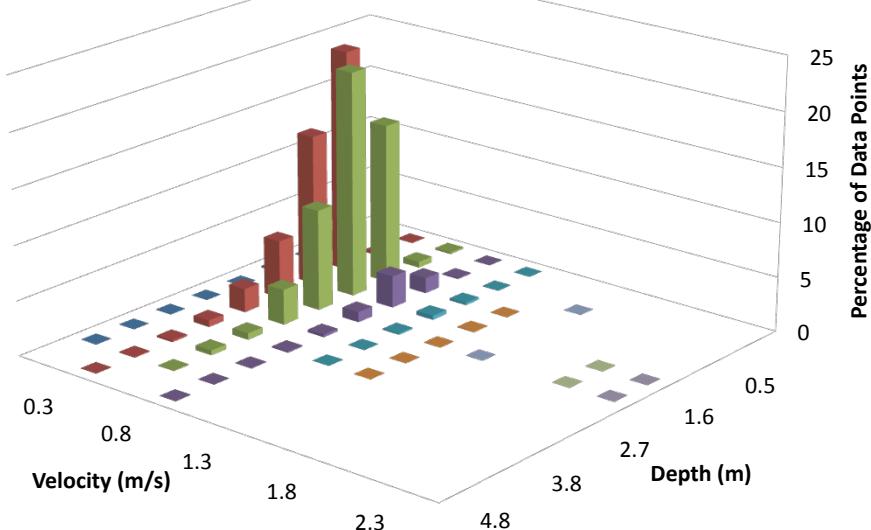
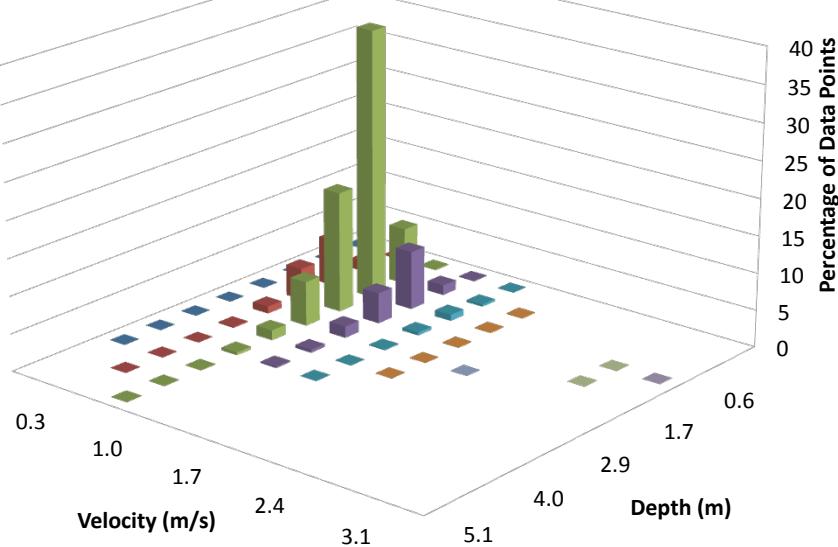
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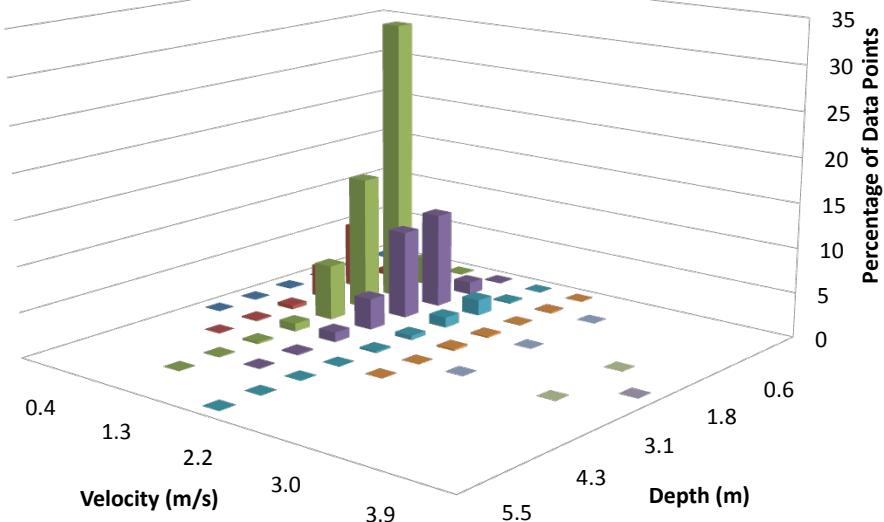
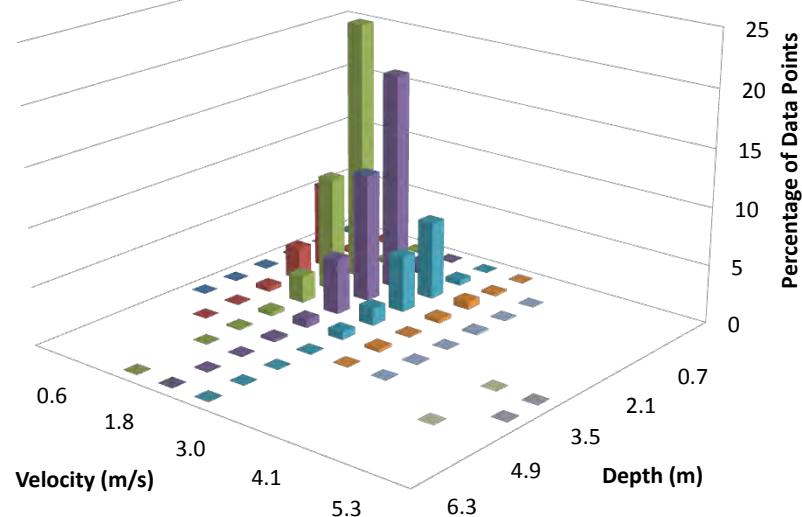
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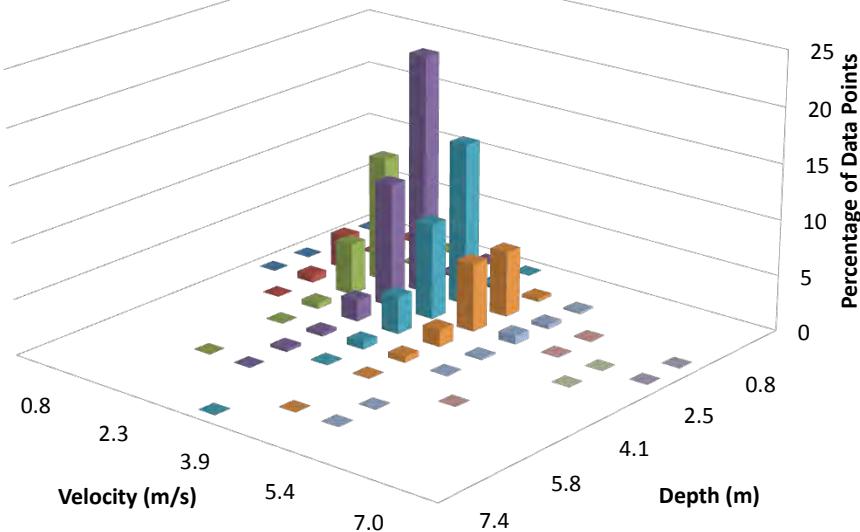
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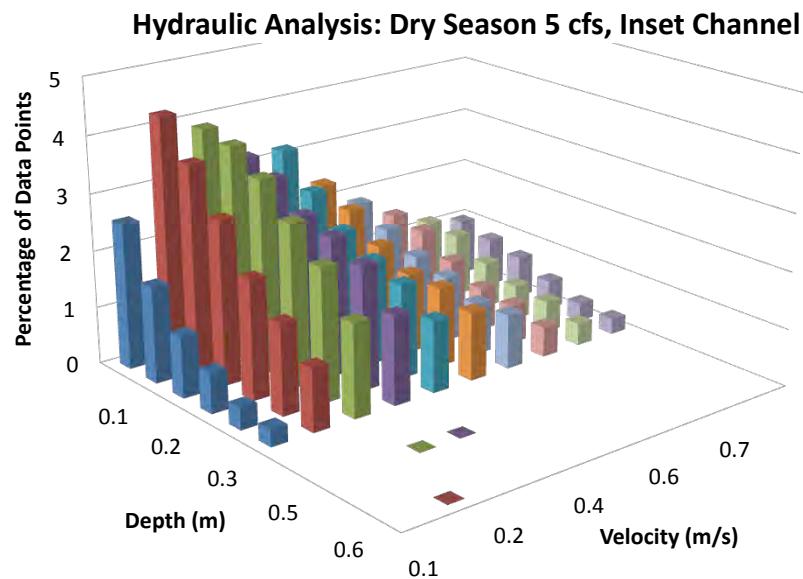


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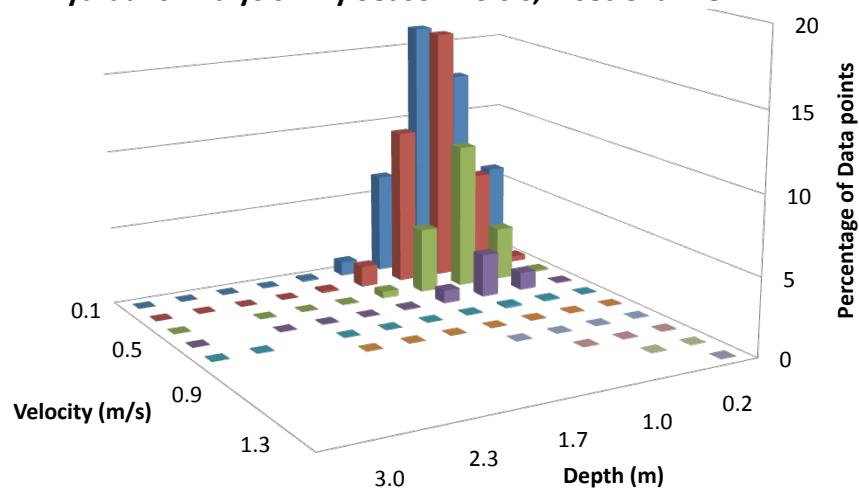
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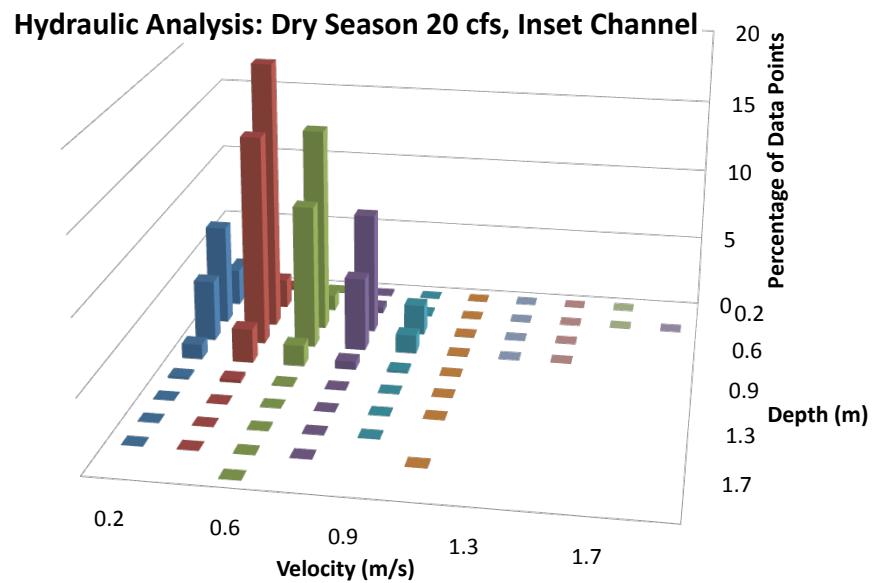
**Hydraulic Analysis: Snow Season 6921 cfs, Chute**

3D joint depth-velocity distributions  
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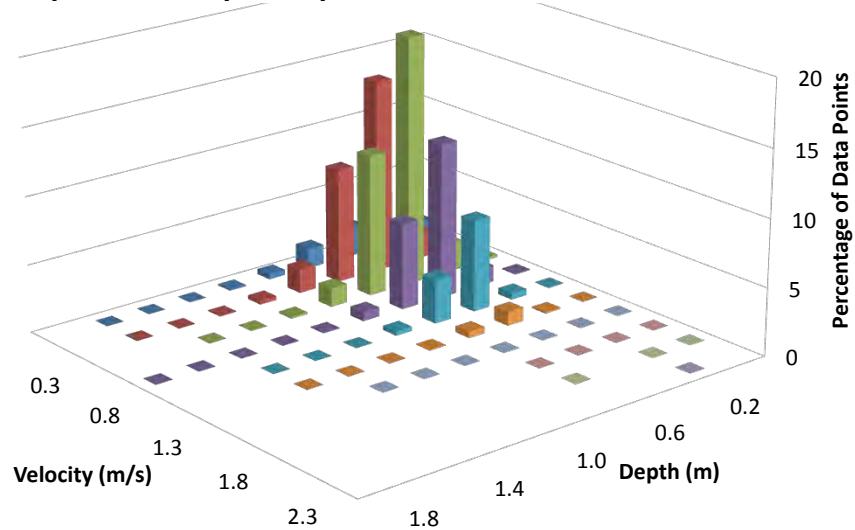


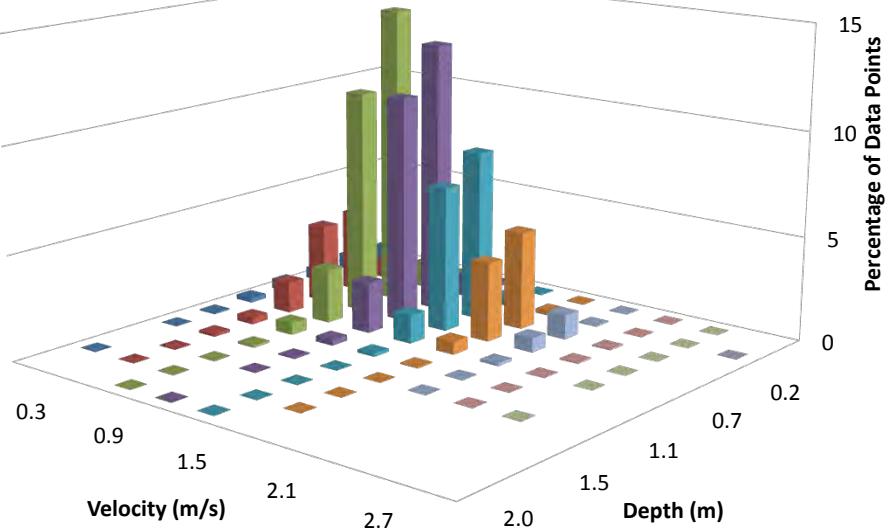
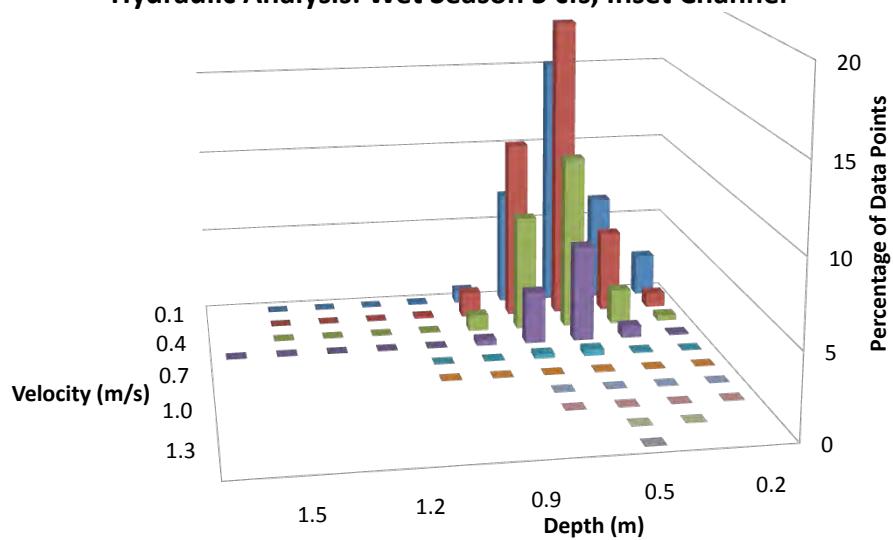
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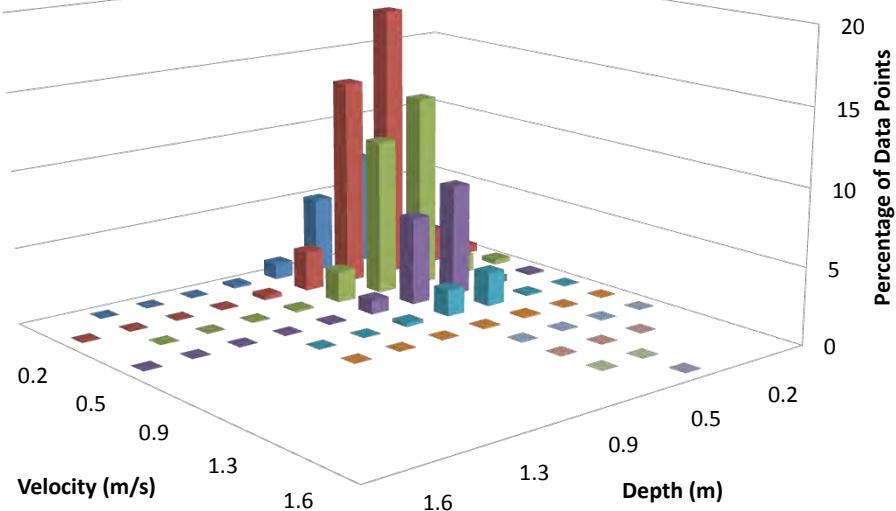
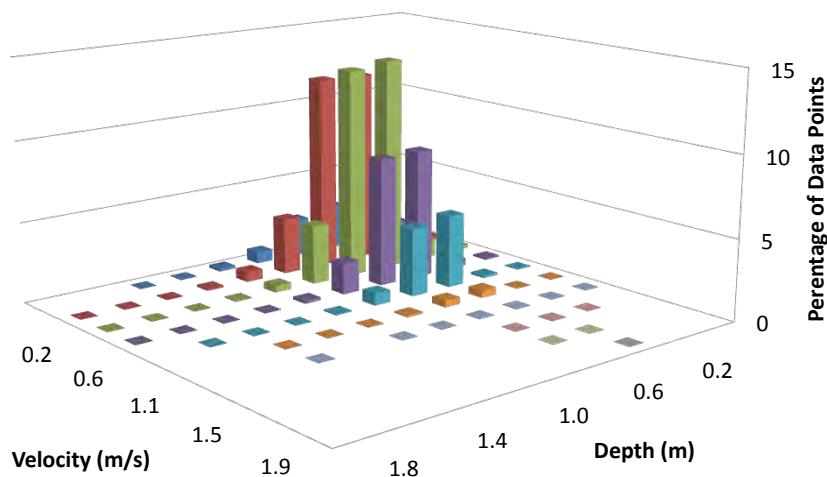


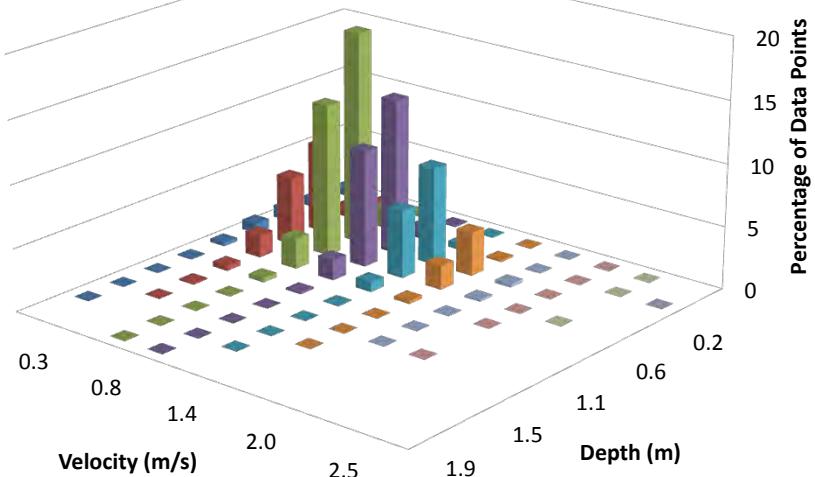
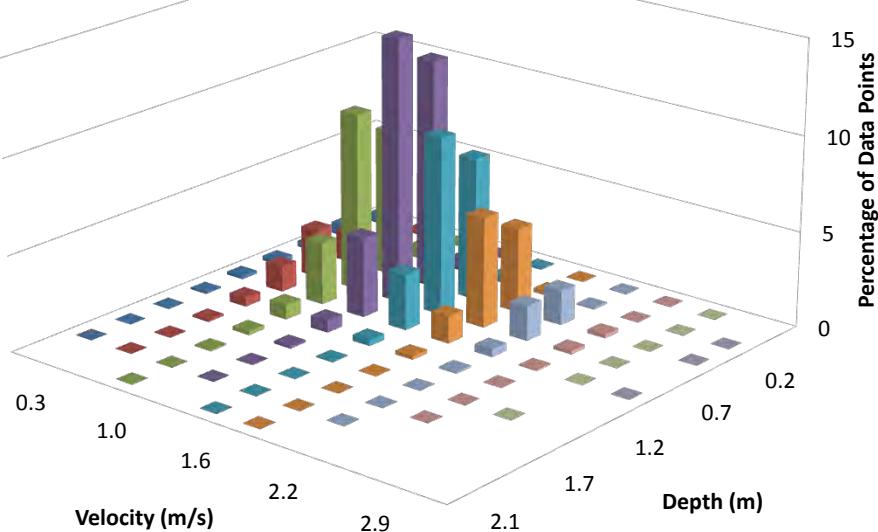


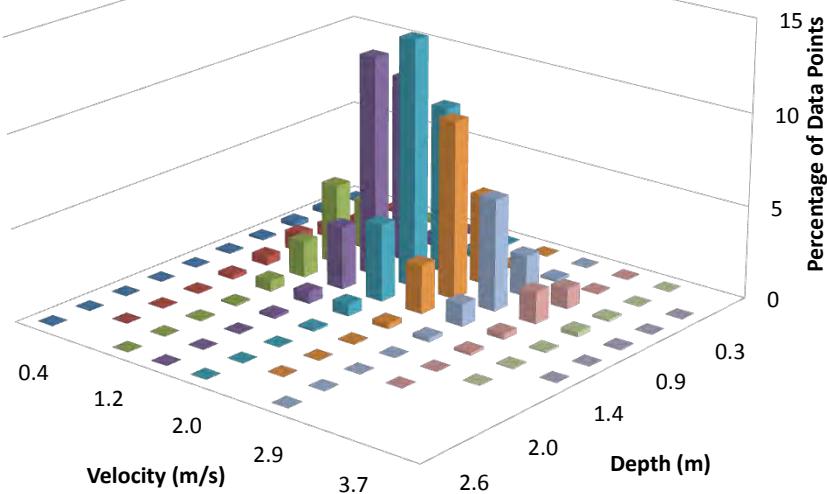
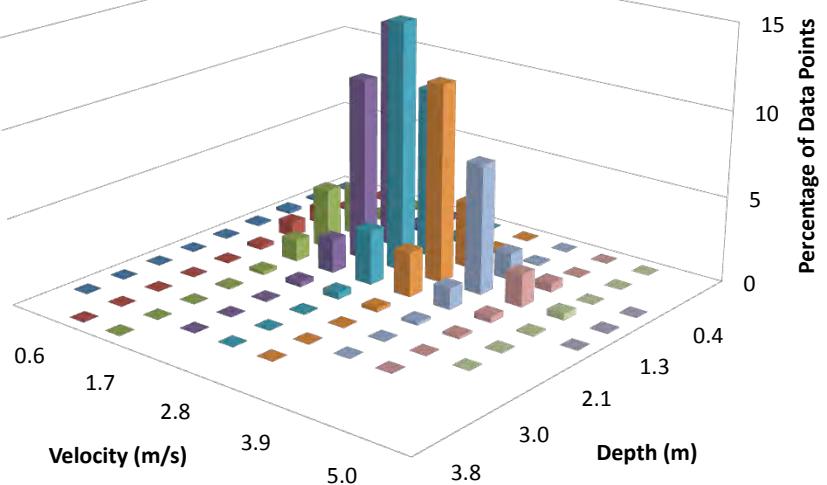
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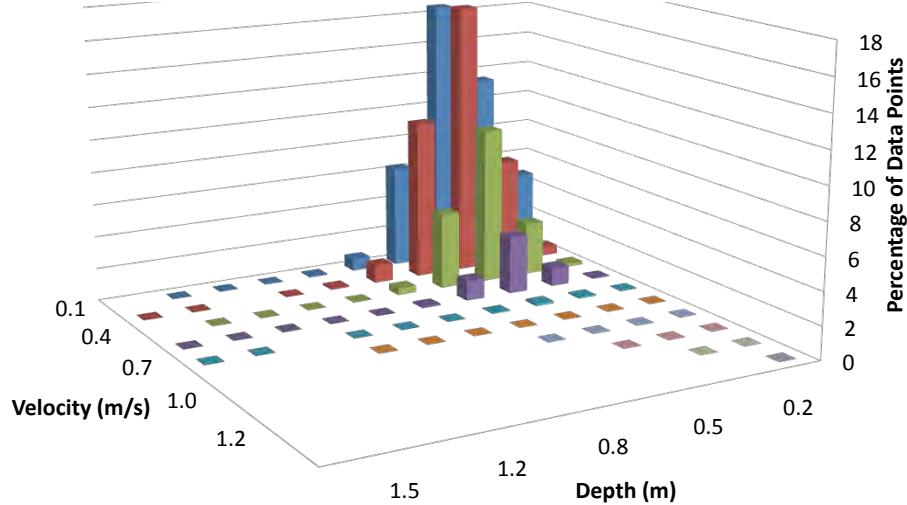
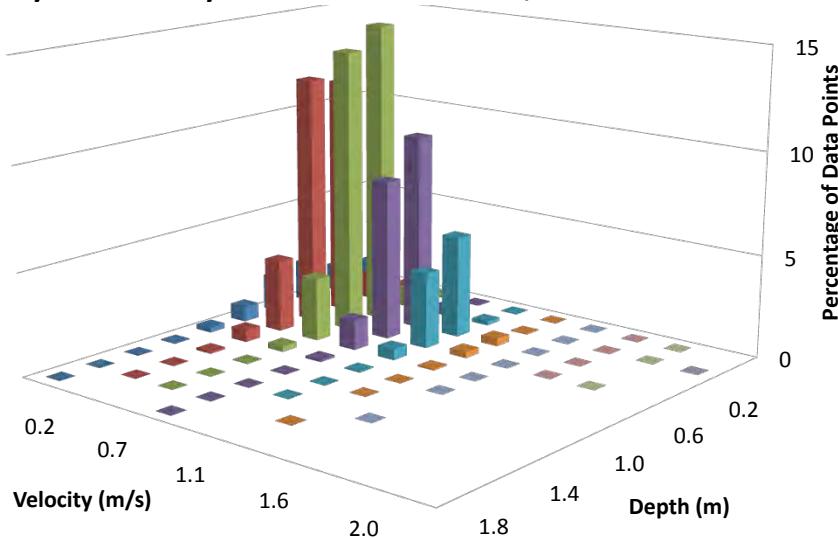


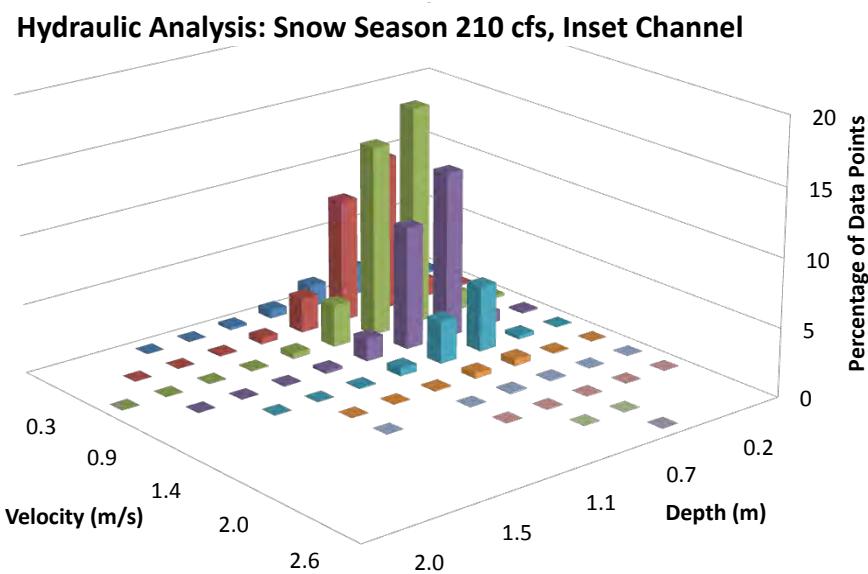
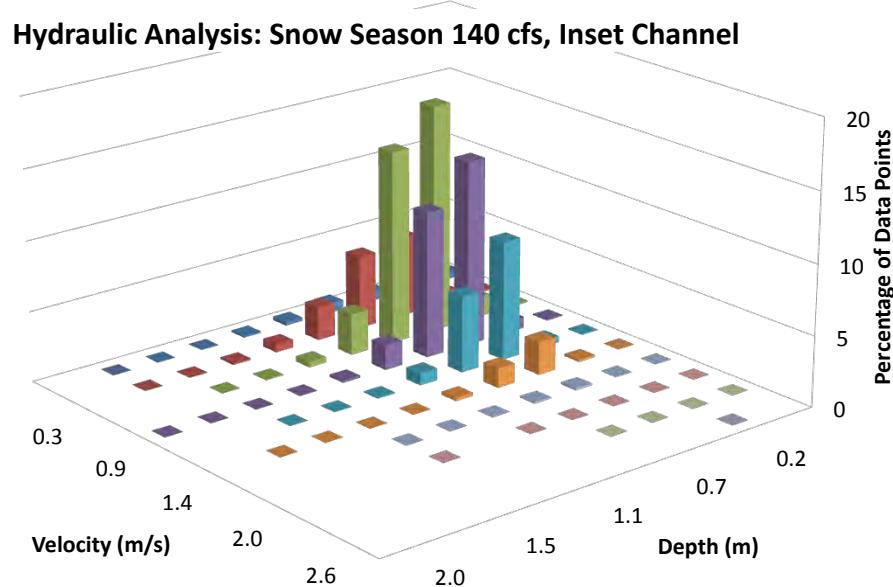
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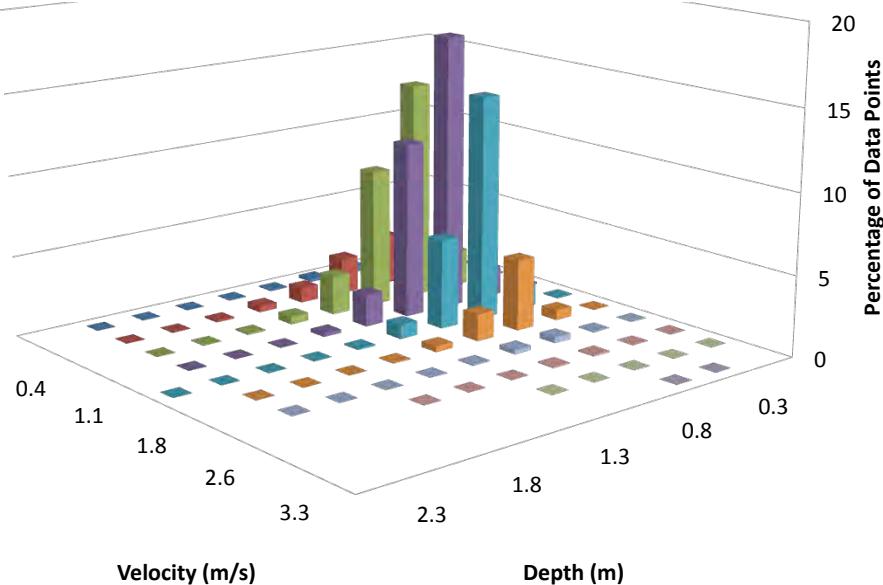
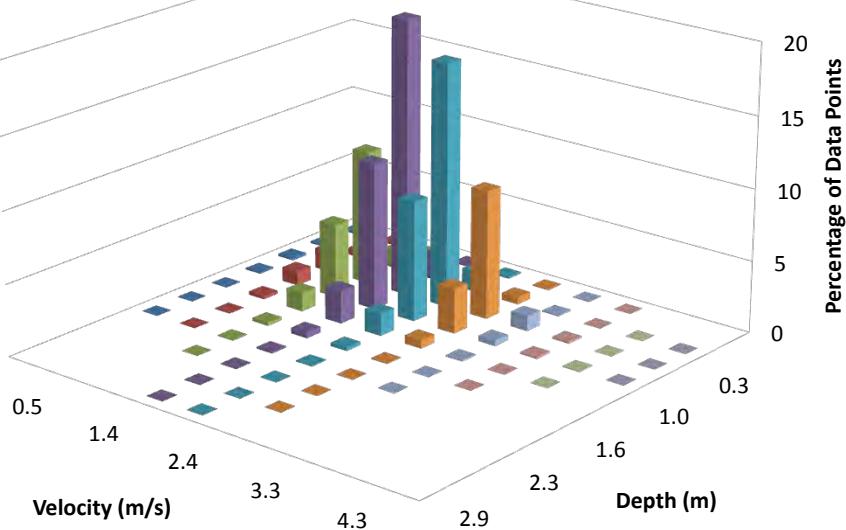
**Hydraulic Analysis: Wet Season 15 cfs, Inset Channel****Hydraulic Analysis: Wet Season 30 cfs, Inset Channel**

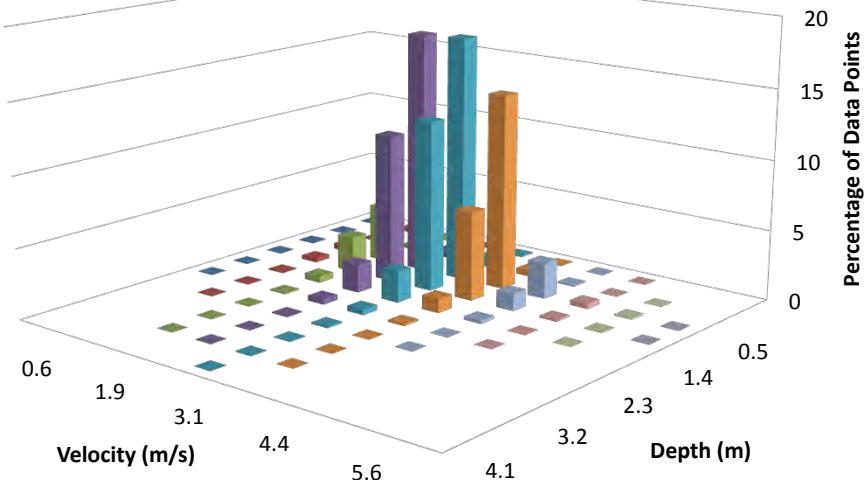
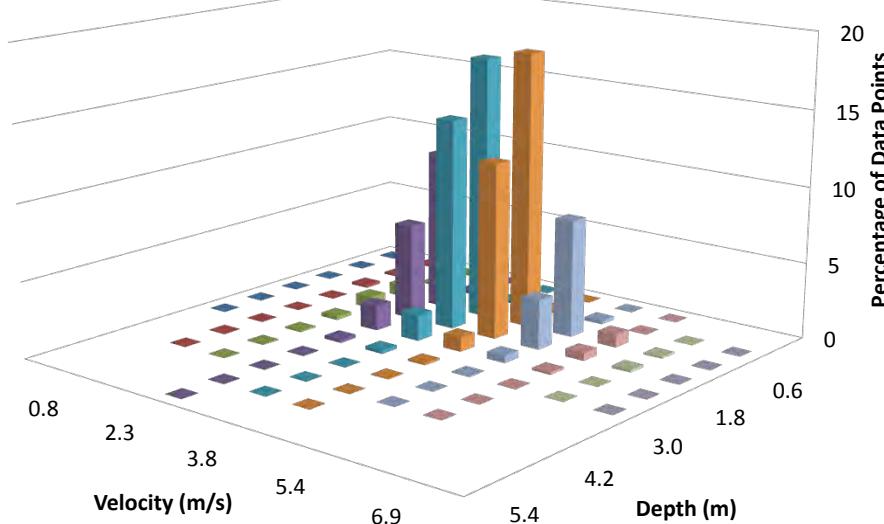
**Hydraulic Analysis: Wet Season 55 cfs, Inset Channel****Hydraulic Analysis: Wet Season 100 cfs, Inset Channel**

**Hydraulic Analysis: Wet Season 190 cfs, Inset Channel****Hydraulic Analysis: Wet Season 350 cfs, Inset Channel**

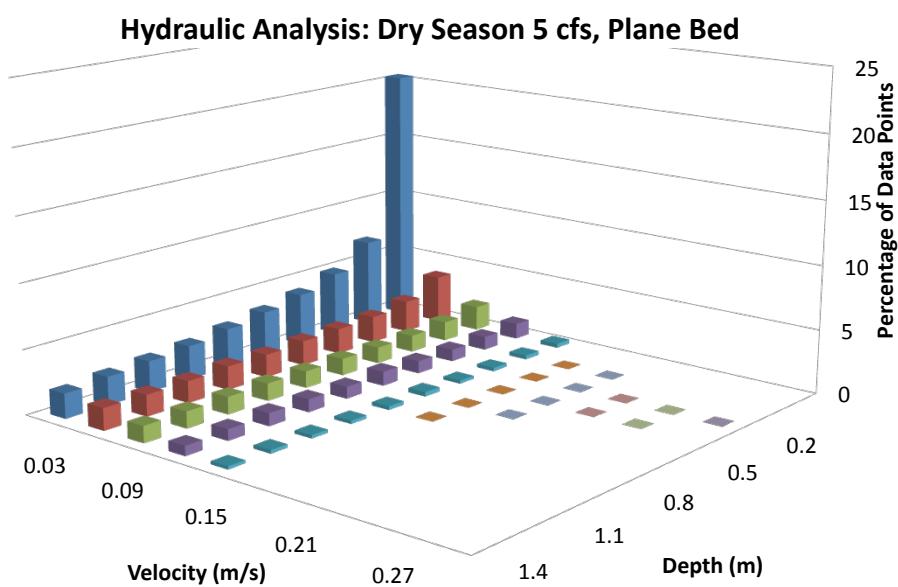
**Hydraulic Analysis: Snow Season 10 cfs, Inset Channel****Hydraulic Analysis: Snow Season 50 cfs, Inset Channel**

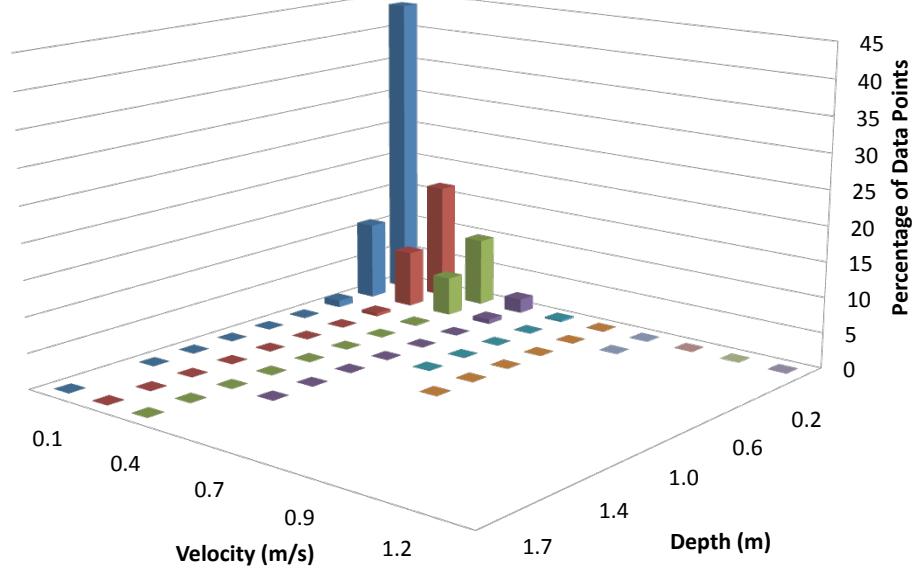
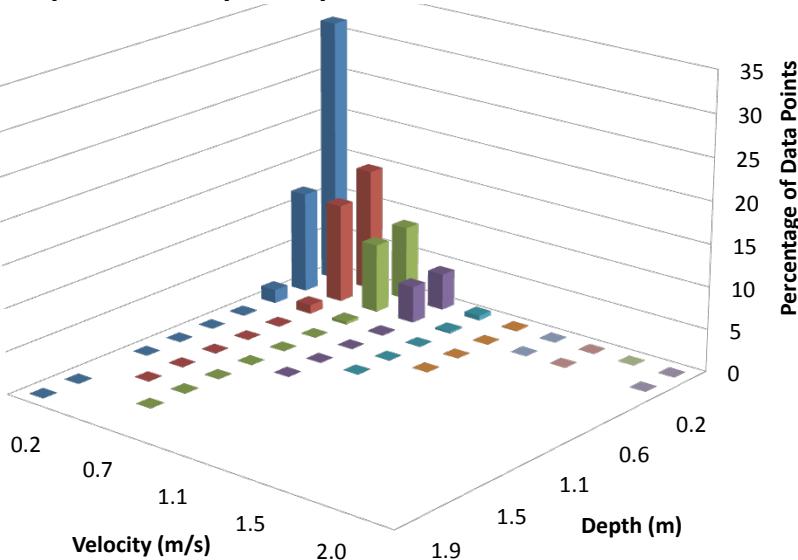


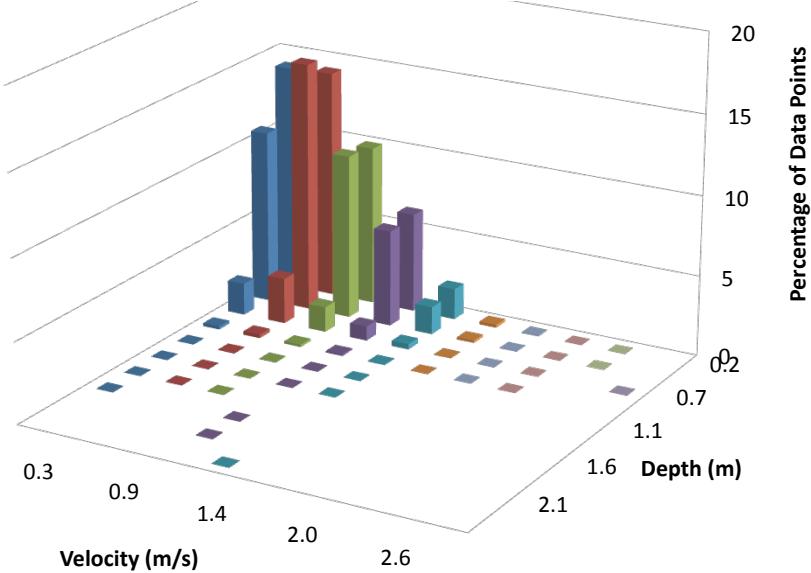
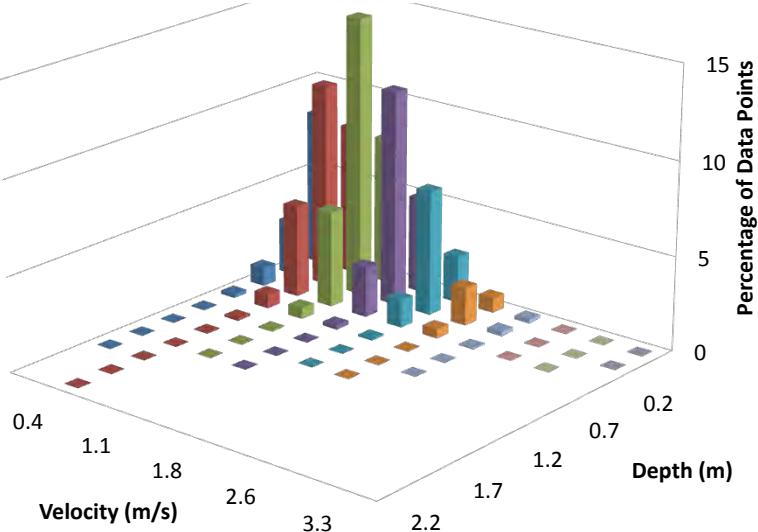
**Hydraulic Analysis: Snow Season 525 cfs, Inset Channel****Hydraulic Analysis: Snow Season 1103 cfs, Inset Channel**

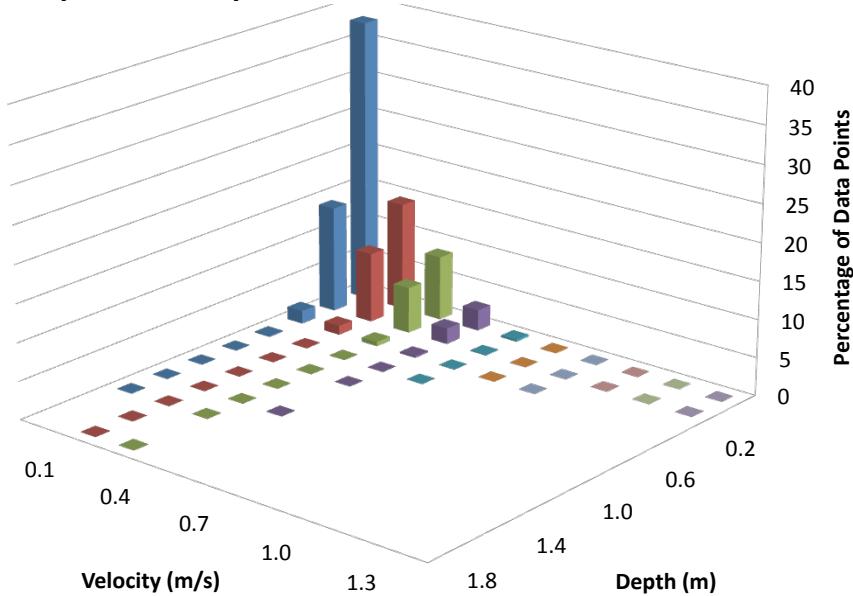
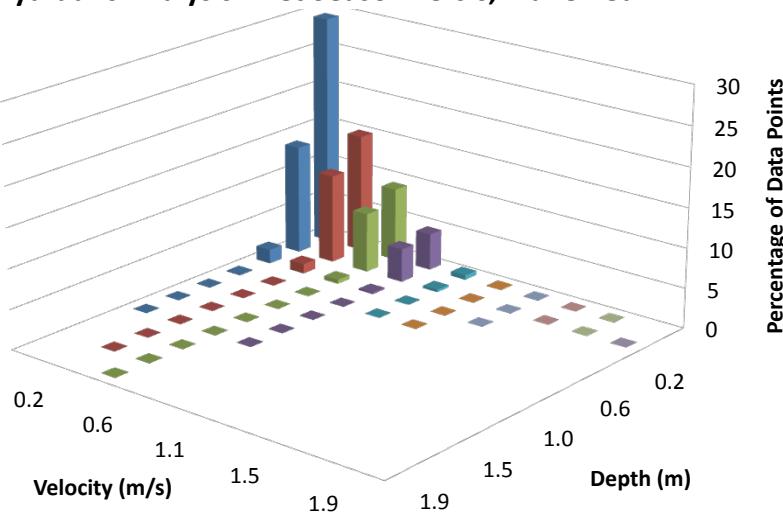
**Hydraulic Analysis: Snow Season 3000 cfs, Inset Channel****Hydraulic Analysis: Snow Season 6921 cfs, Inset Channel**

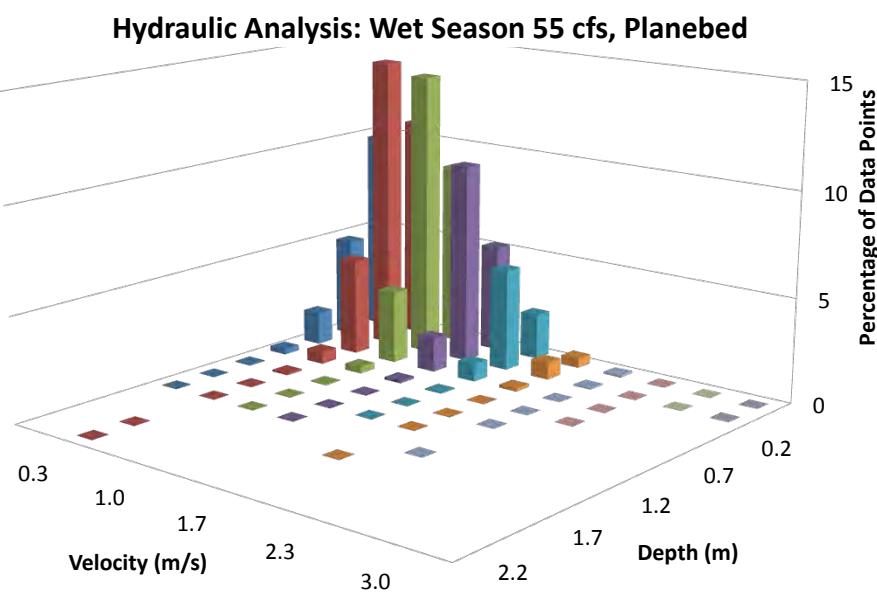
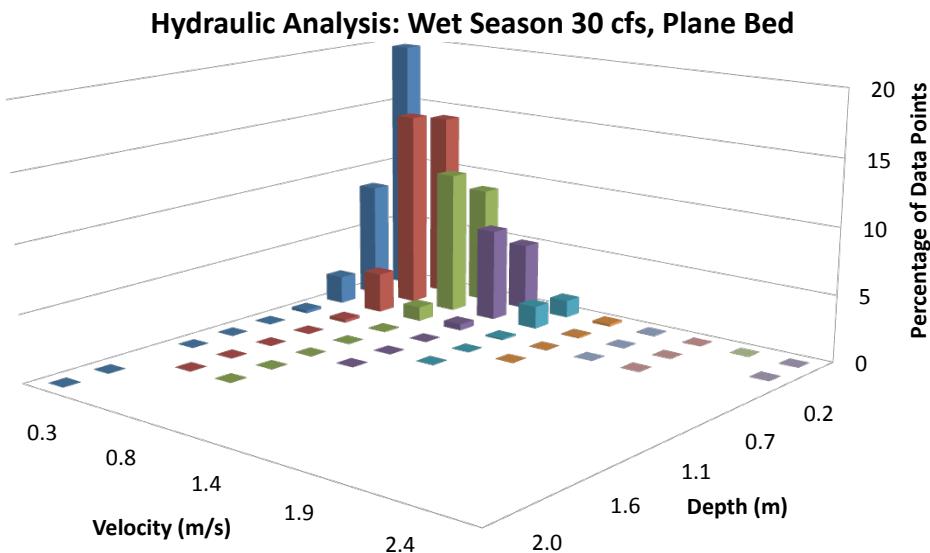
3D joint depth-velocity distributions  
across all flows and seasons,  
stratified by plane bed morphologic  
units

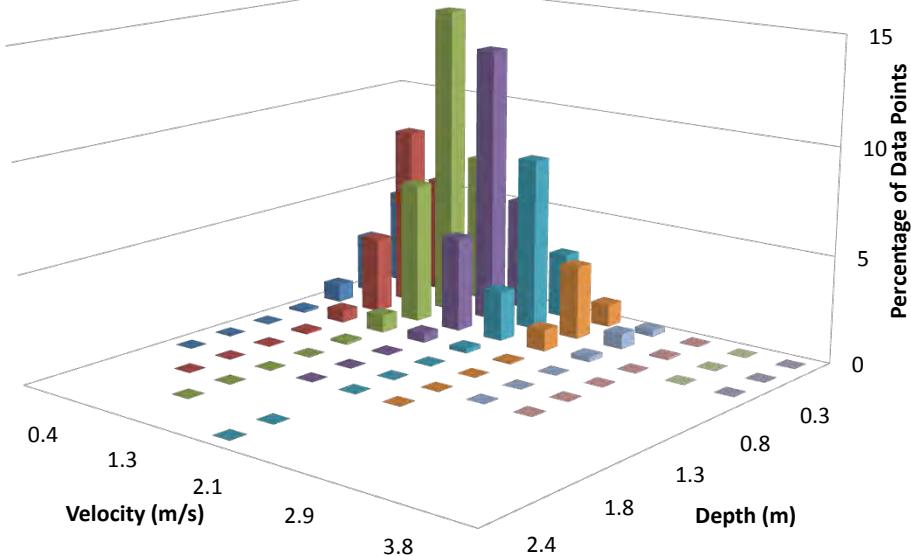
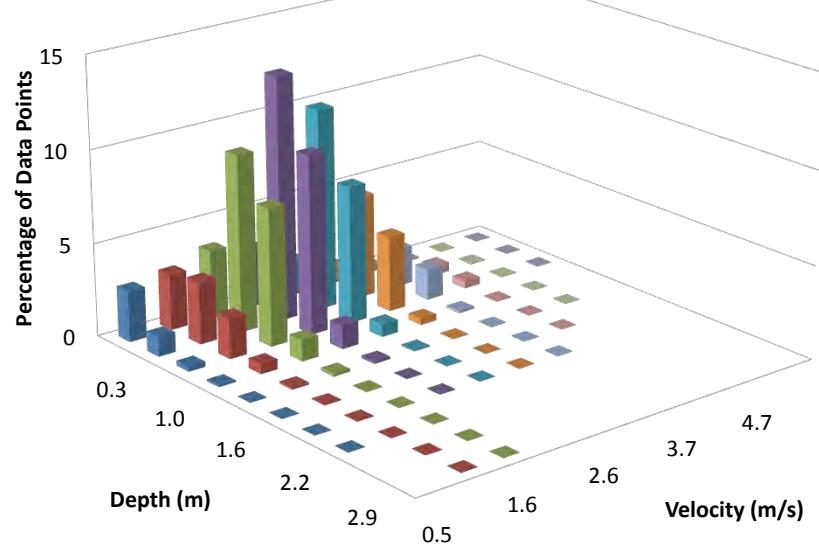


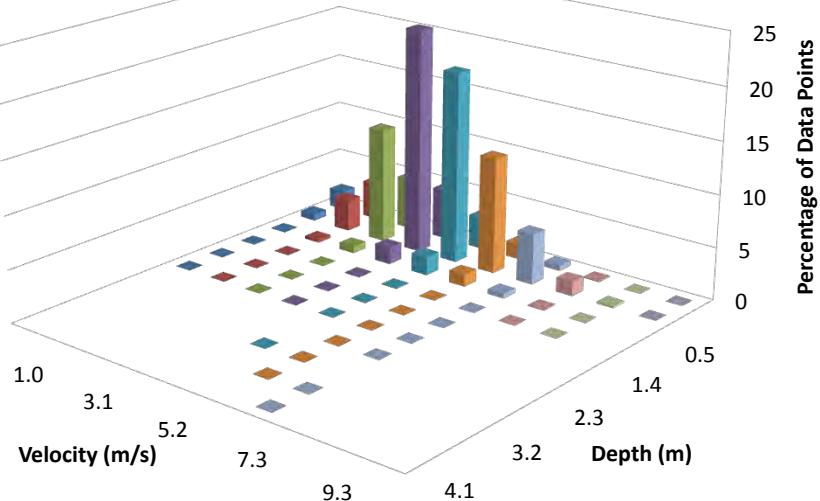
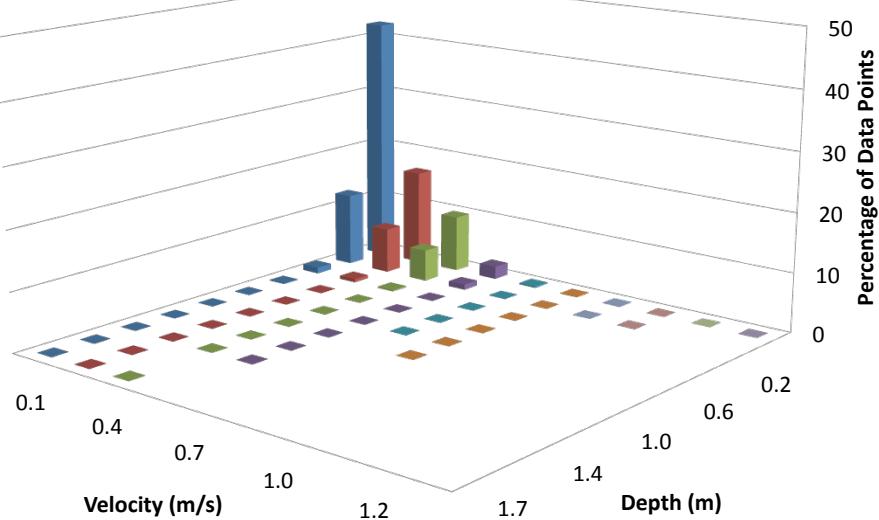
**Hydraulic Analysis: Dry Season 10 cfs, Plane Bed****Hydraulic Analysis: Dry Season 20 cfs, Planebed**

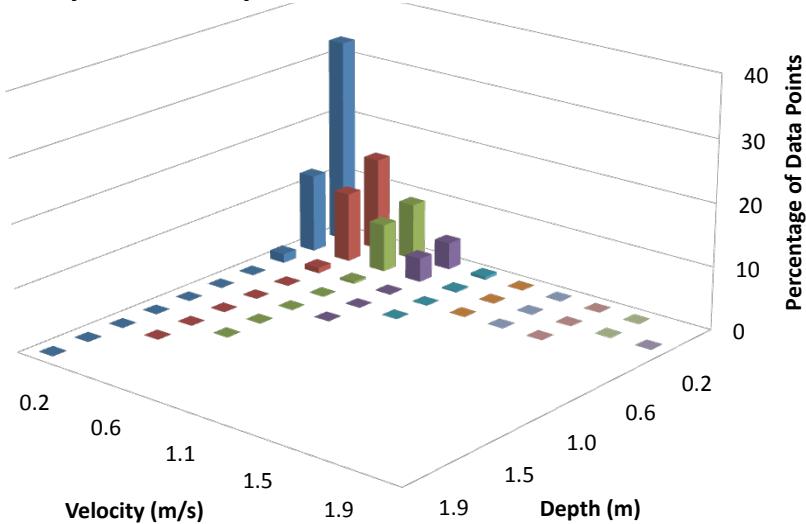
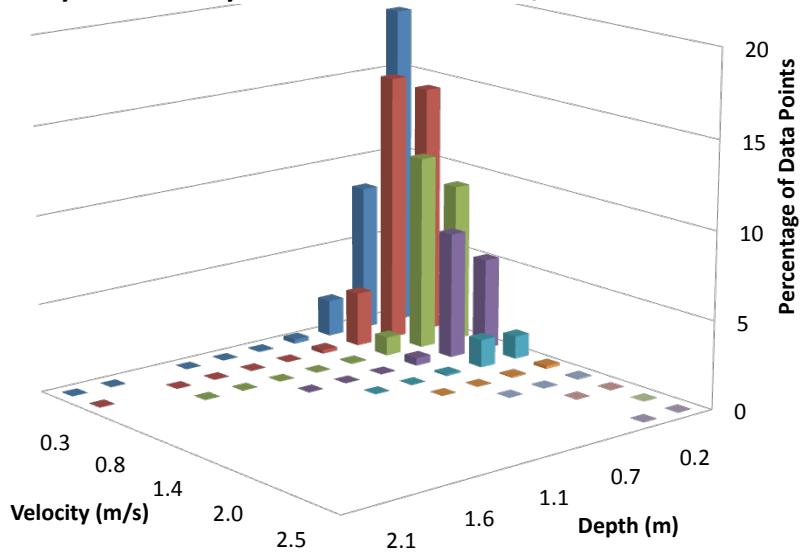
**Hydraulic Analysis: Dry Season 30 cfs, Plane Bed****Hydraulic Analysis: Dry Season 45 cfs, Plane Bed**

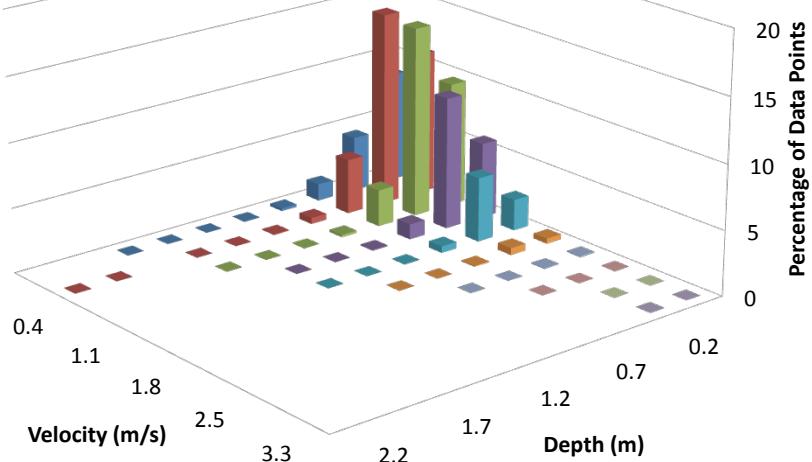
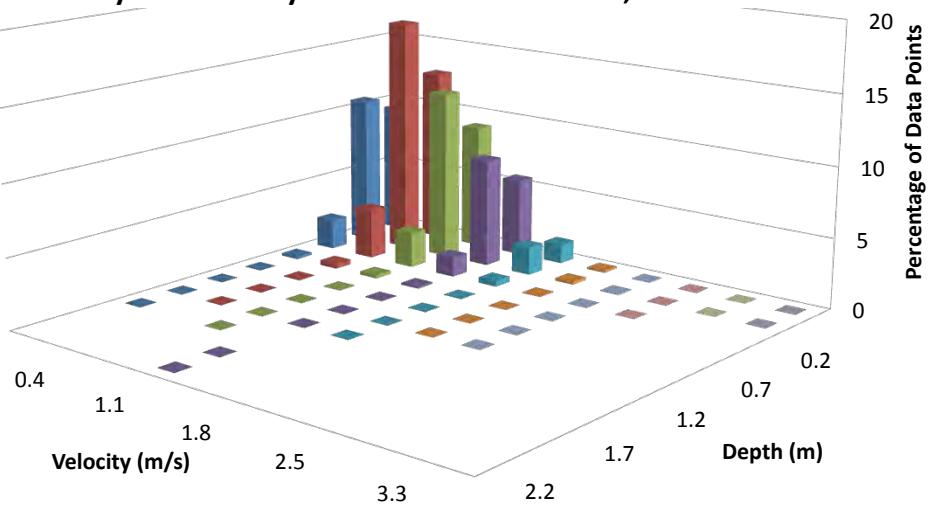
**Hydraulic Analysis: Wet Season 5 cfs, Plane Bed****Hydraulic Analysis: Wet Season 15 cfs, Plane Bed**

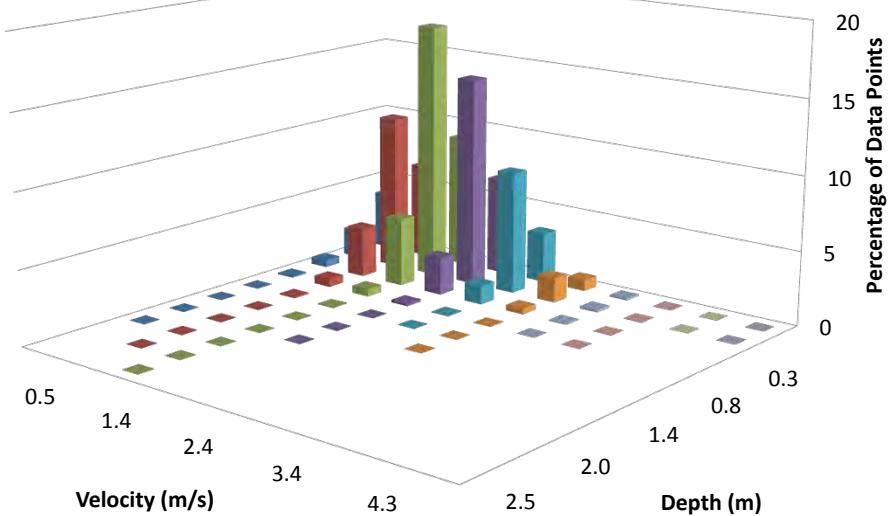
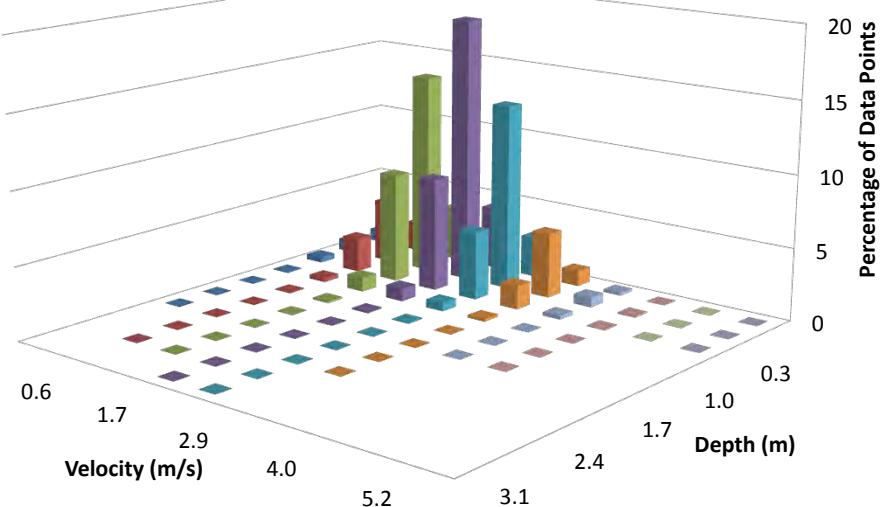


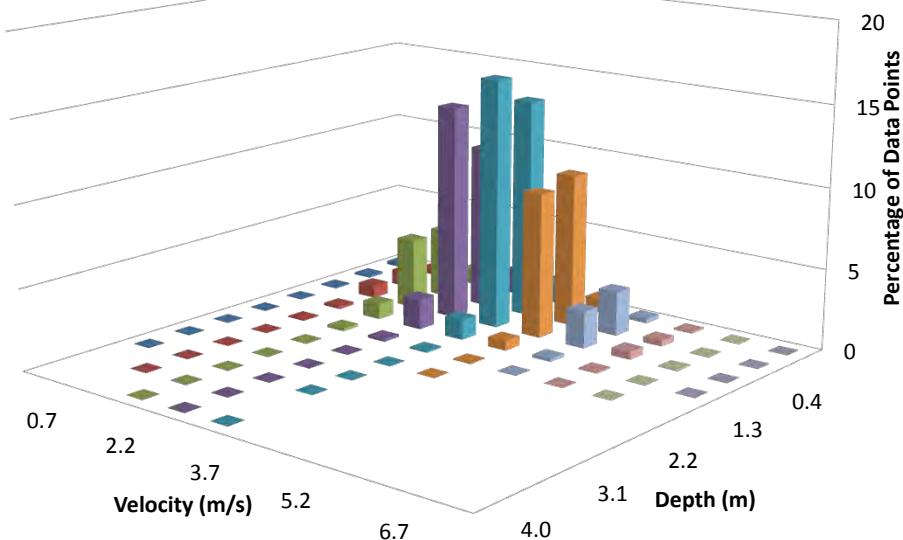
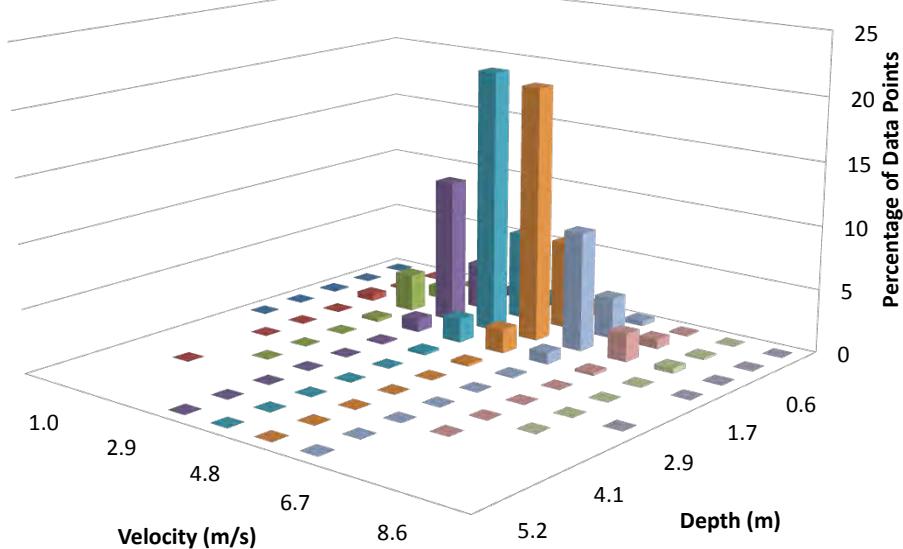
**Hydraulic Analysis: Wet Season 100 cfs, Plane Bed****Hydraulic Analysis: Wet Season 190 cfs, Plane Bed**

**Hydraulic Analysis: Wet Season 350 cfs, Plane Bed****Hydraulic Analysis: Snow Season 10 cfs, Plane Bed**

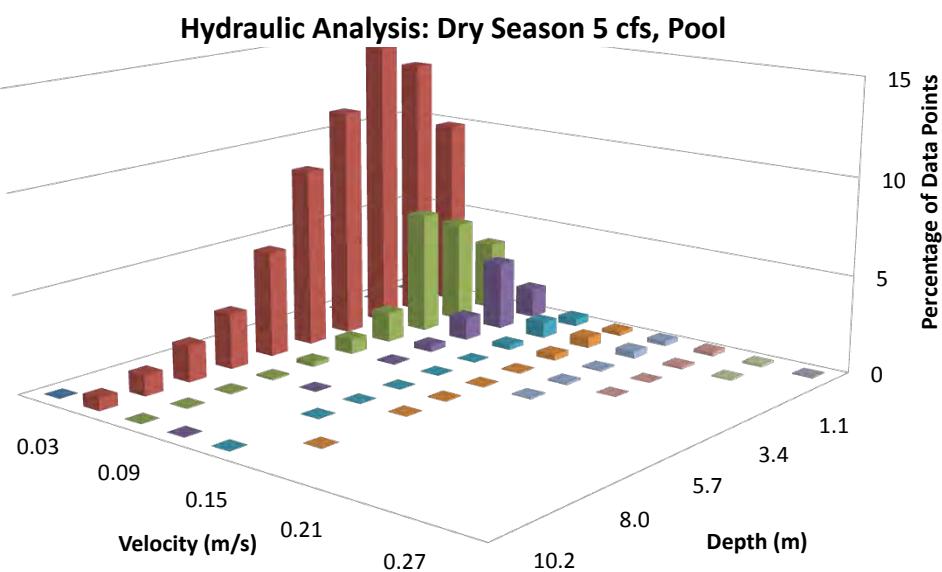
**Hydraulic Analysis: Snow Season 25 cfs, Plane Bed****Hydraulic Analysis: Snow Season 50 cfs, Plane Bed**

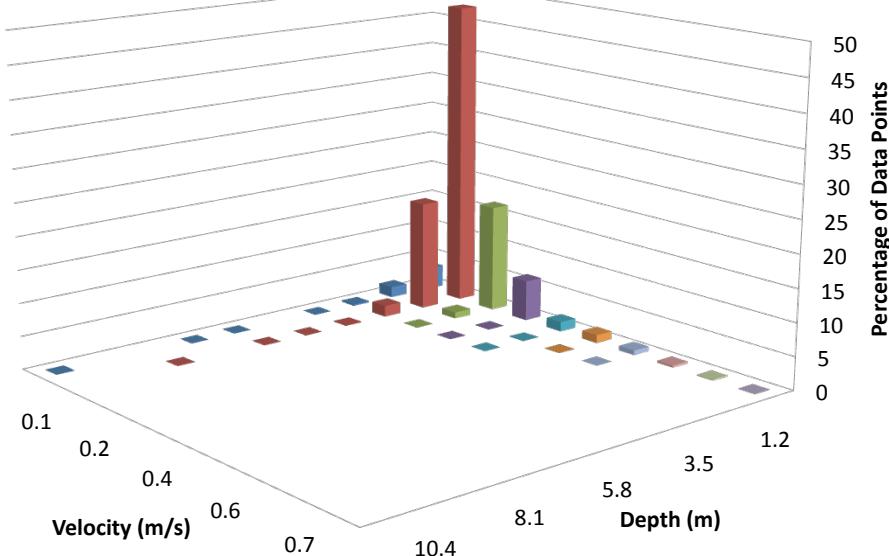
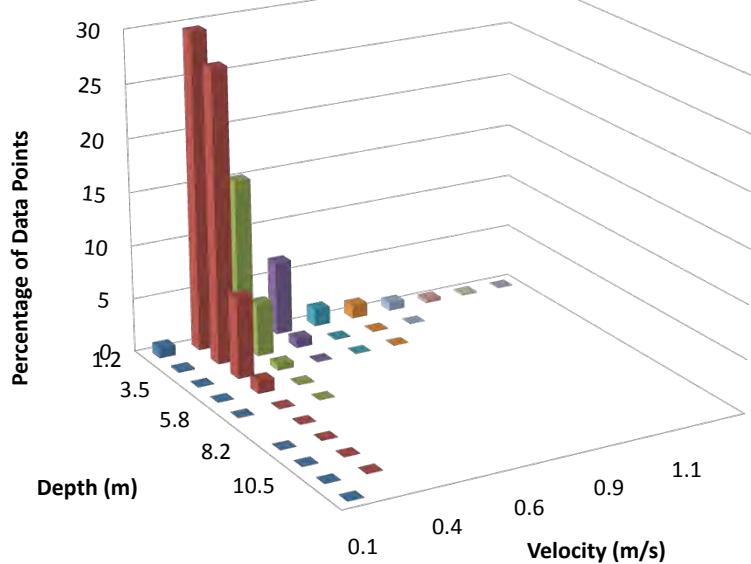
**Hydraulic Analysis: Snow Season 140 cfs, Plane Bed****Hydraulic Analysis: Snow Season 210 cfs, Plane Bed**

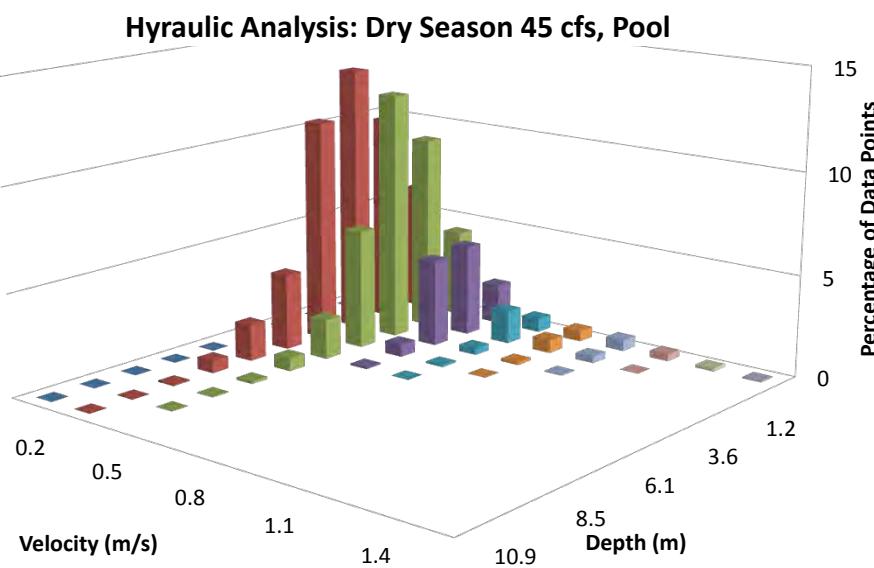
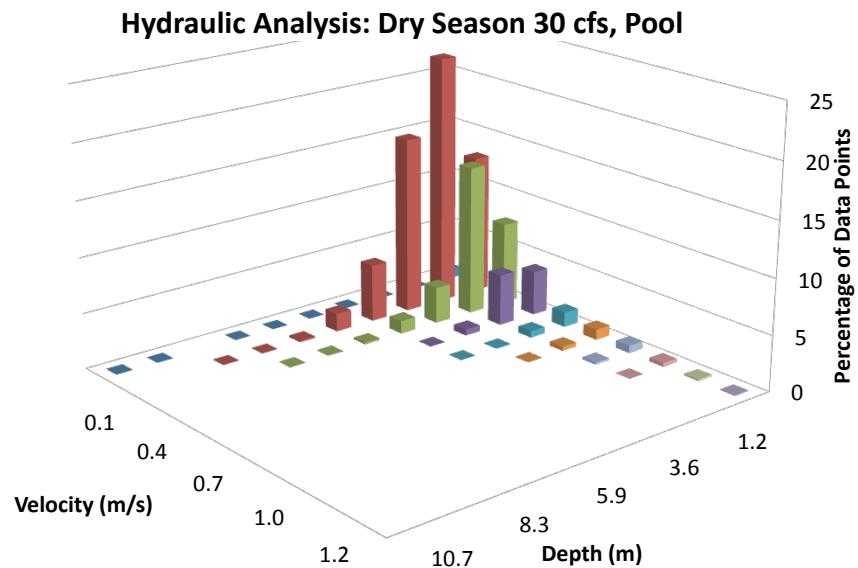
**Hydraulic Analysis: Snow Season 525 cfs, Plane Bed****Hydraulic Analysis: Snow Season 1103 cfs, Plane Bed**

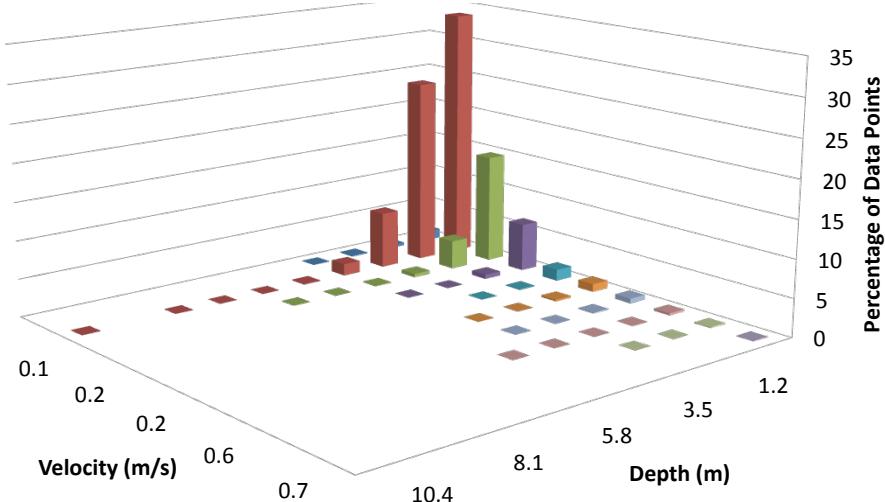
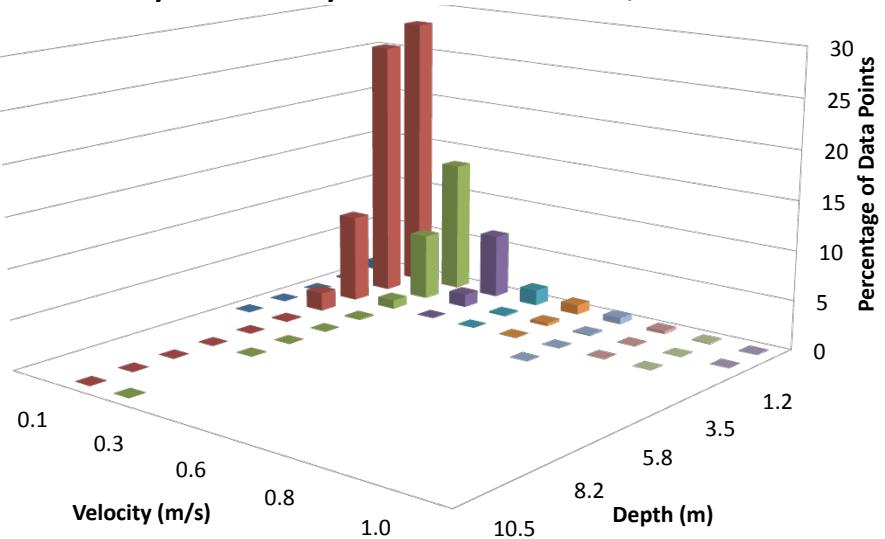
**Hydraulic Analysis: Snow Season 3000 cfs, Plane Bed****Hydraulic Analysis: Snow Season 6921 cfs, Plane Bed**

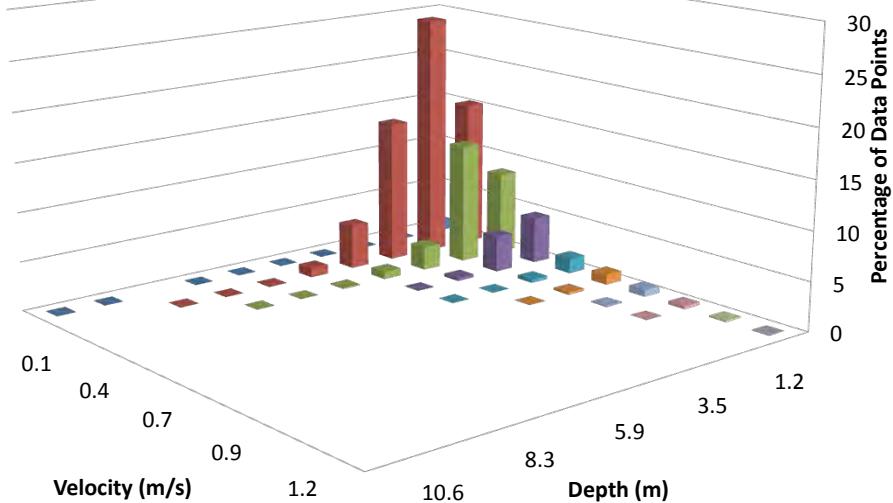
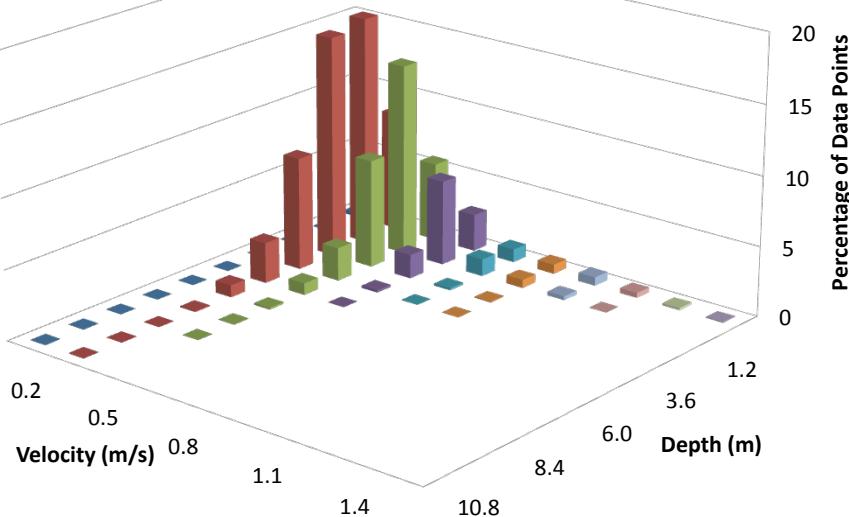
3D joint depth-velocity distributions  
across all flows and seasons,  
stratified by pool morphologic units

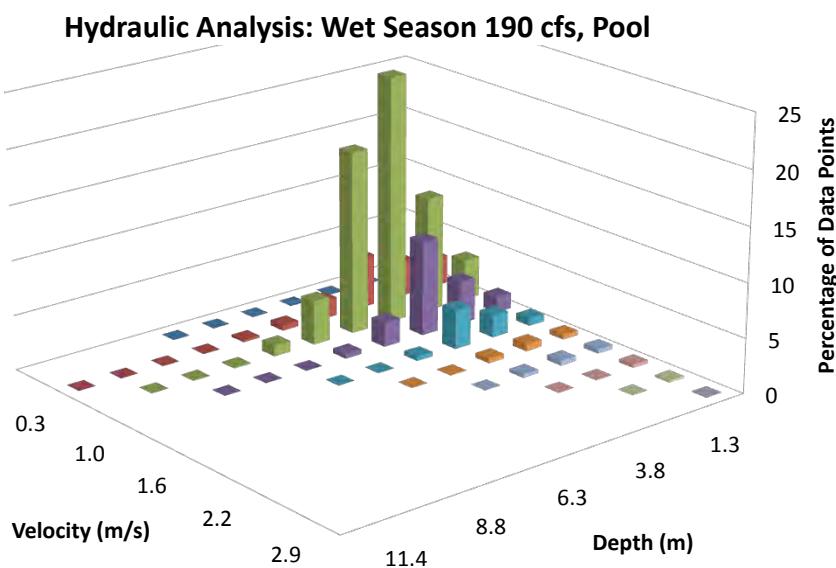
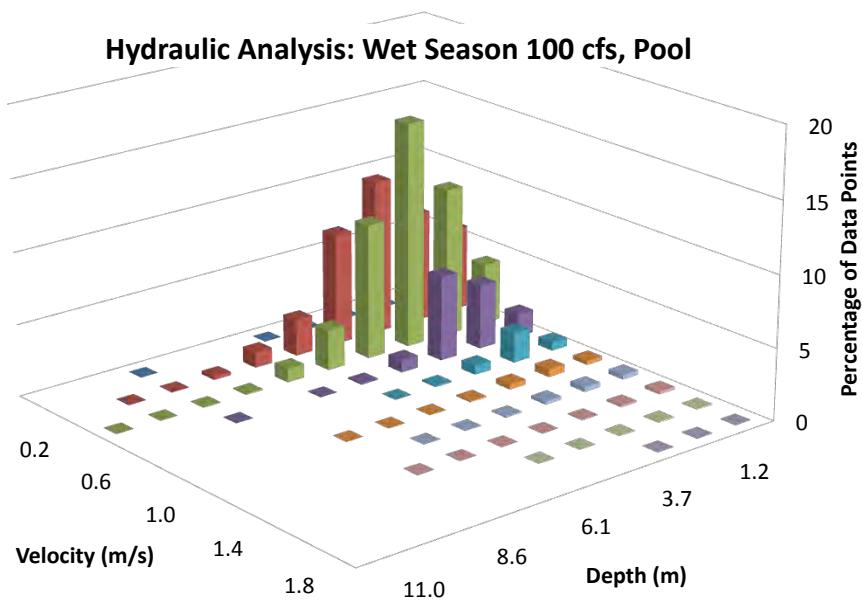


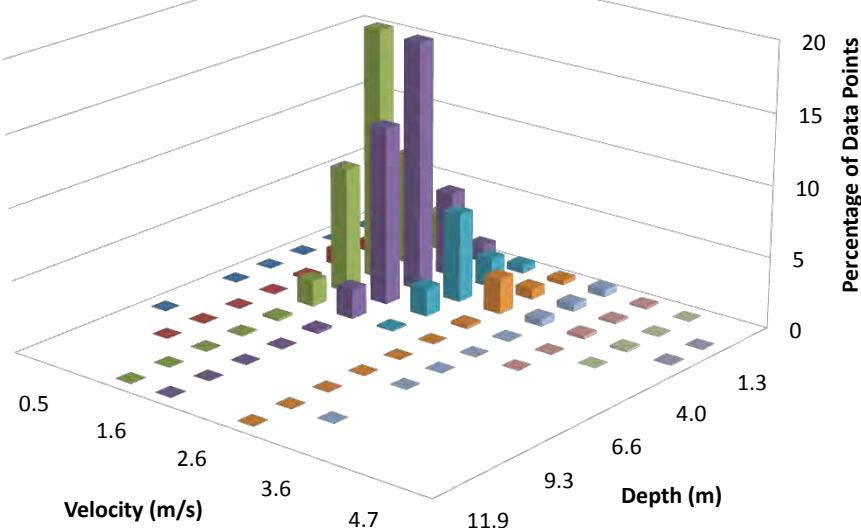
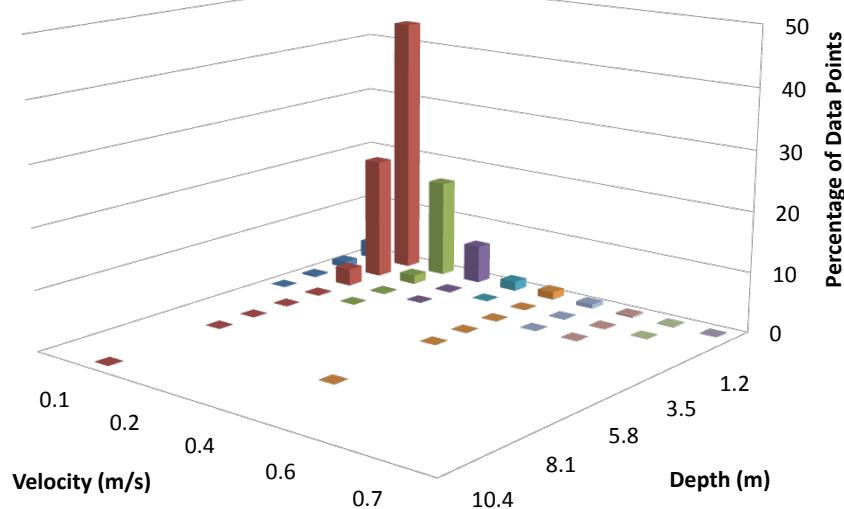
**Hydraulic Analysis: Dry Season 10 cfs, Pool****Hydraulic Analysis: Dry Season 20 cfs, Pool**

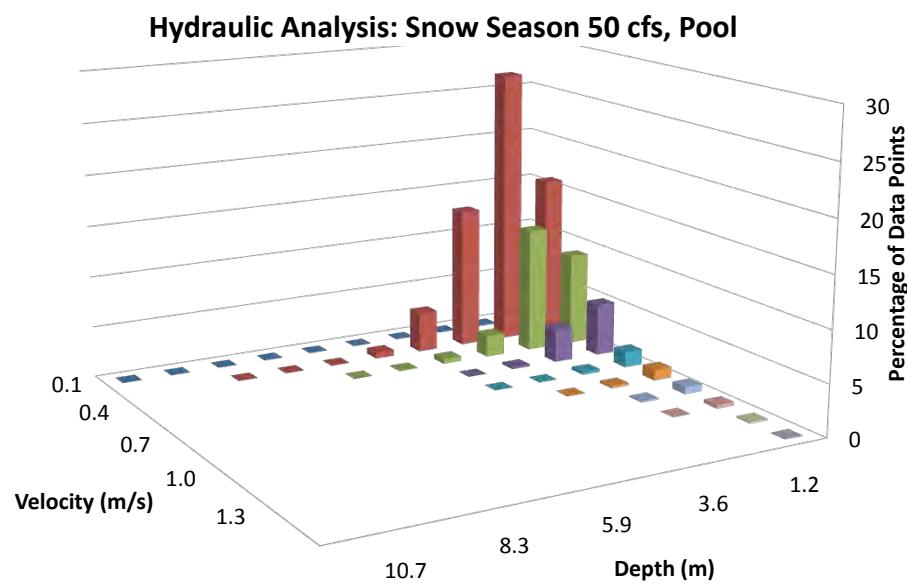
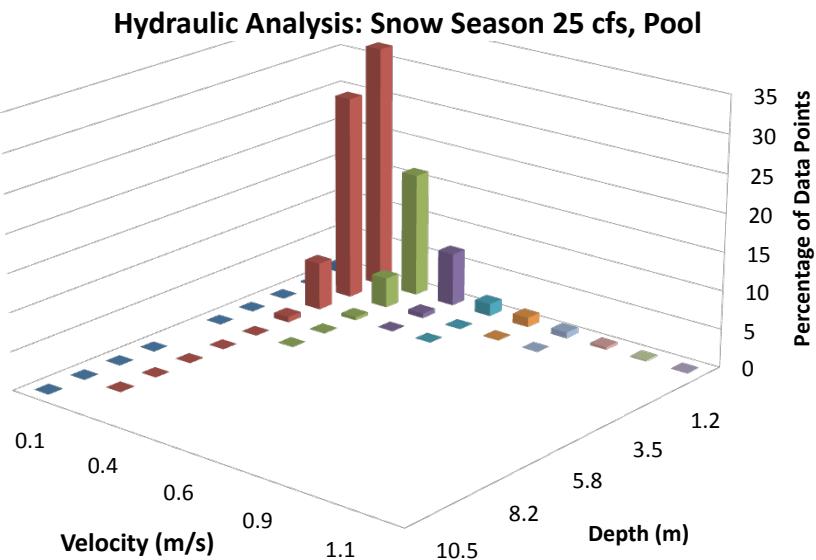


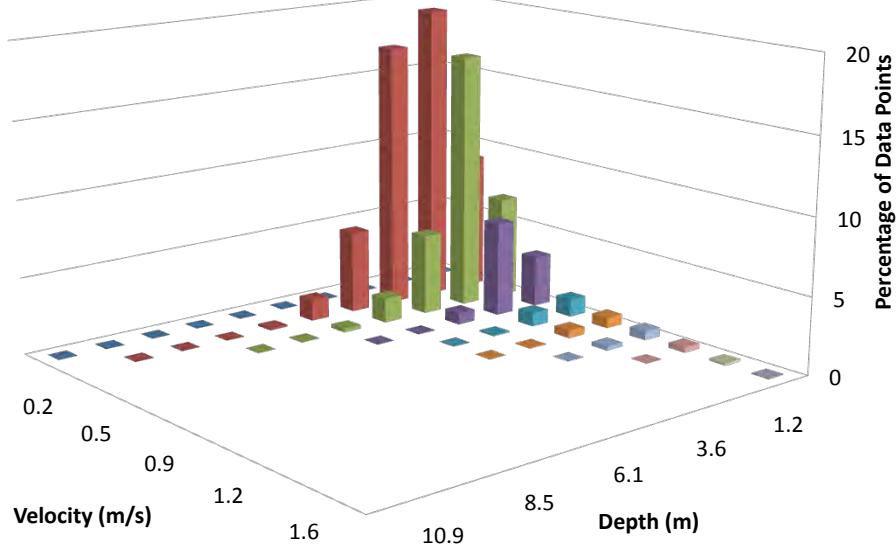
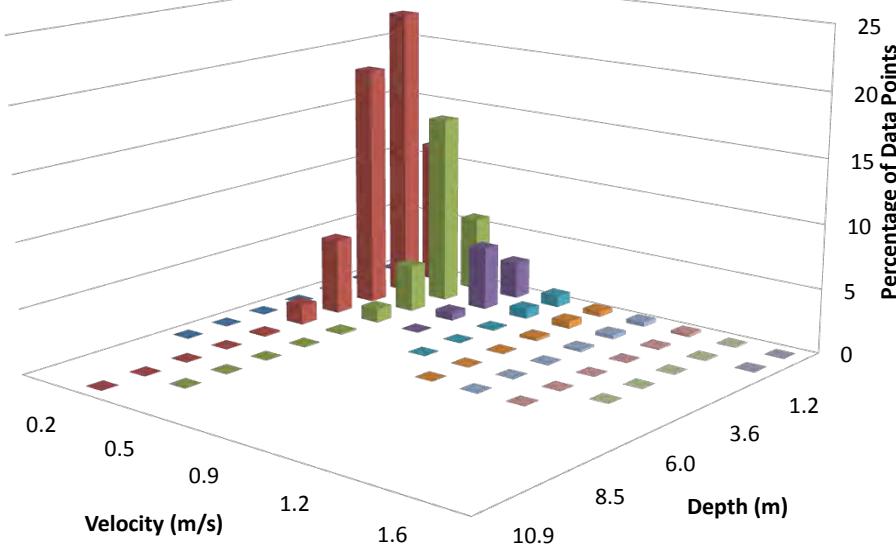
**Hydraulic Analysis: Wet Season 5 cfs, Pool****Hydraulic Analysis: Wet Season 15 cfs, Pool**

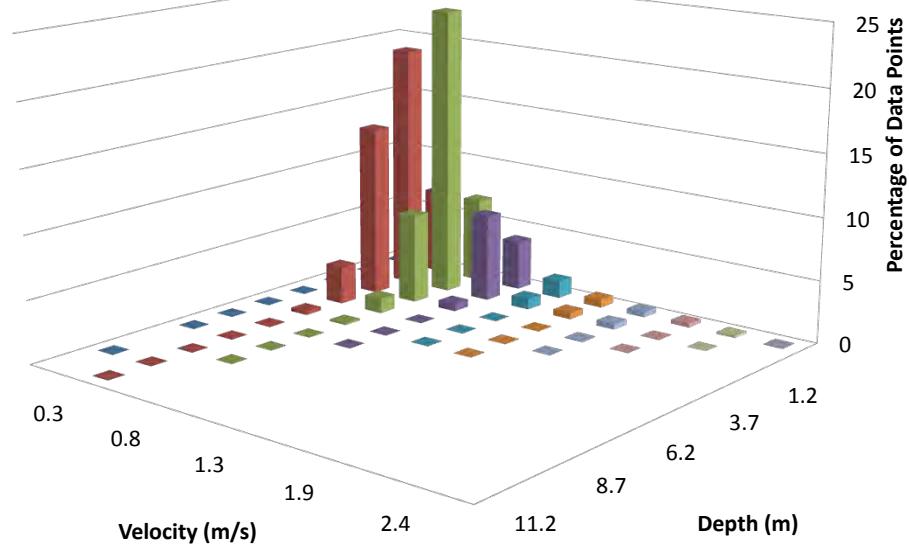
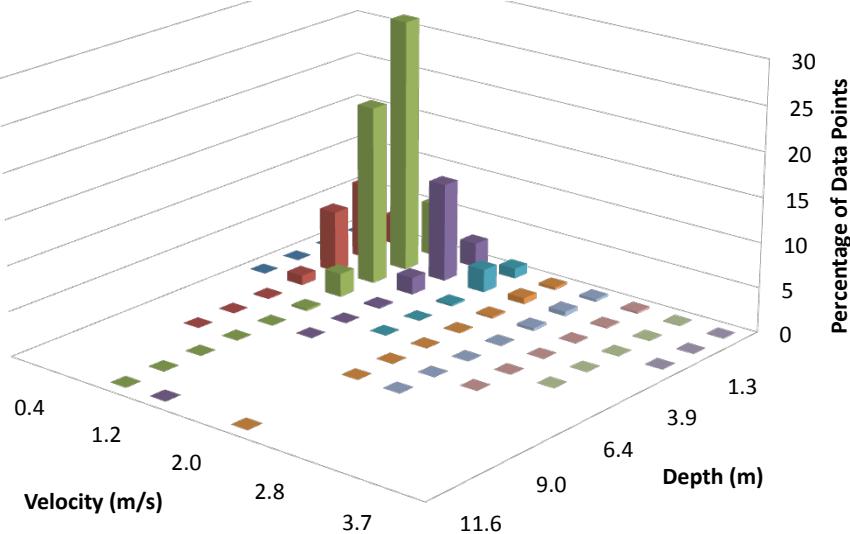
**Hydraulic Analysis: Wet Season 30 cfs, Pool****Hydraulic Analysis: Wet Season 55 cfs, Pool**

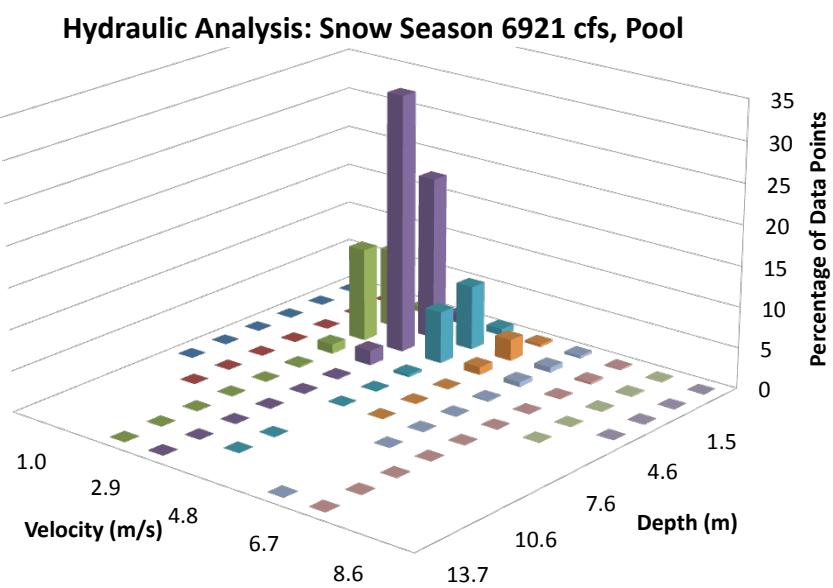
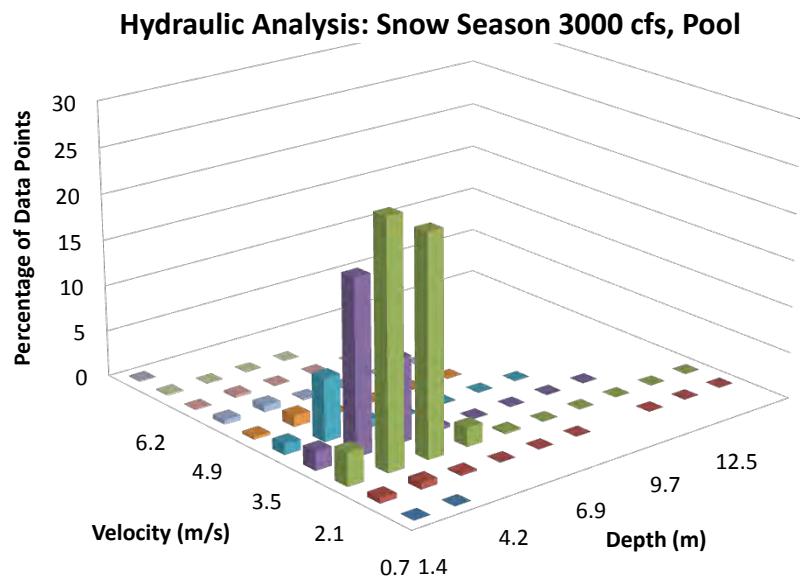


**Hydraulic Analysis: Wet Season 350 cfs, Pool****Hydraulic Analysis: Snow Season 10 cfs, Pool**

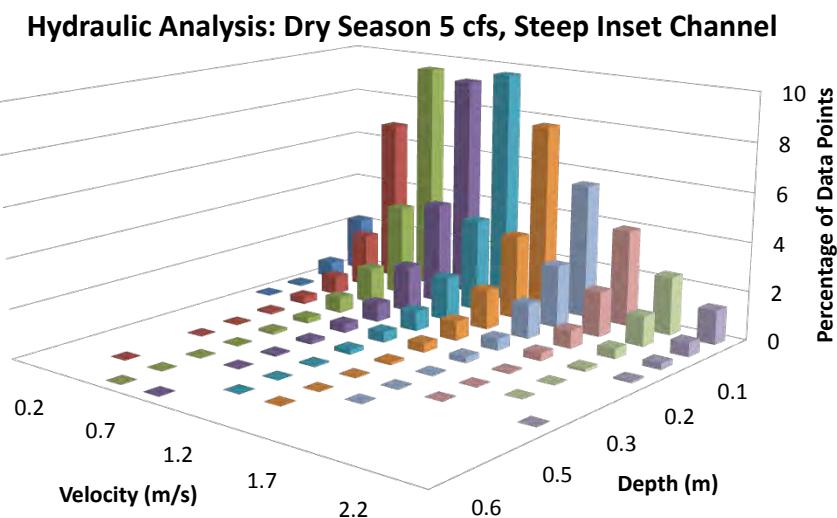


**Hydraulic Analysis: Snow Season 140 cfs, Pool****Hydraulic Analysis: Snow Season 210 cfs, Pool**

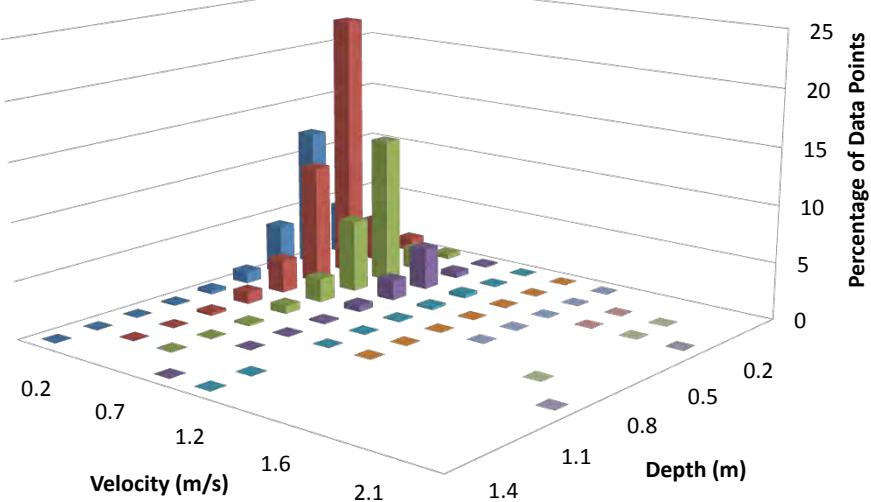
**Hydraulic Analysis: Snow Season 525 cfs, Pool****Hydraulic Analysis: Snow Season 1103 cfs, Pool**



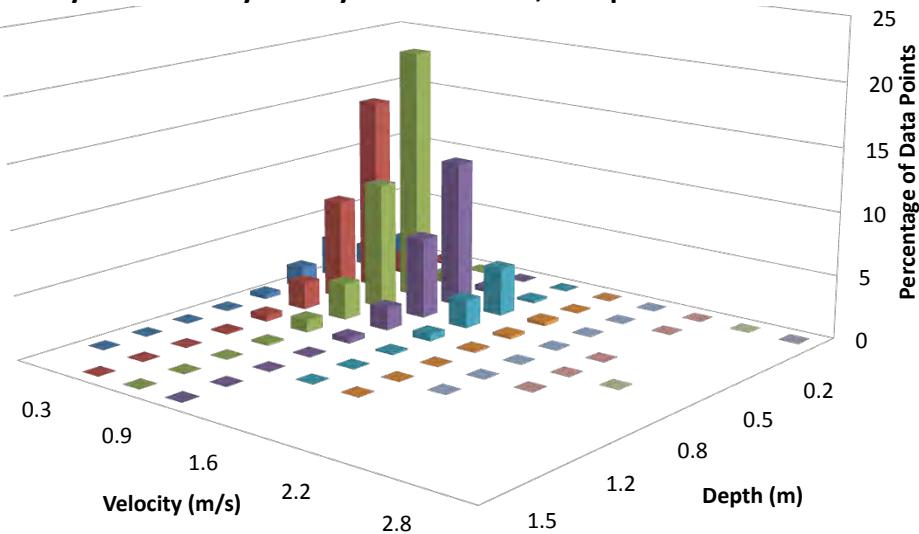
3D joint depth-velocity distributions  
across all flows and seasons,  
stratified by steep inset channel  
morphologic units

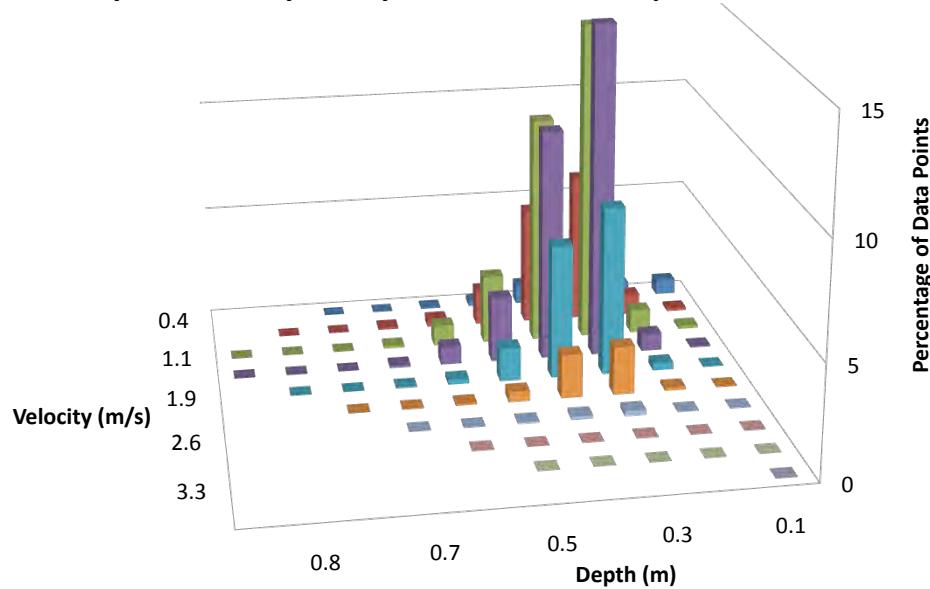
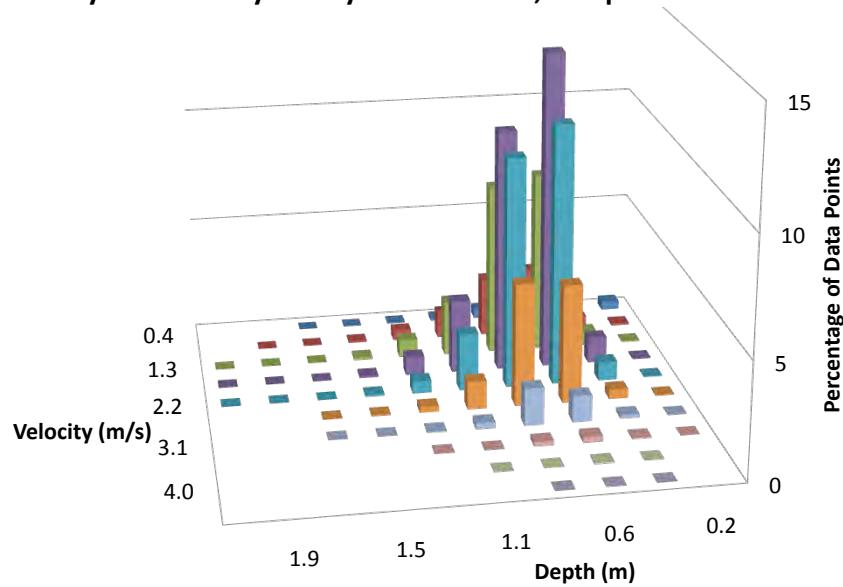


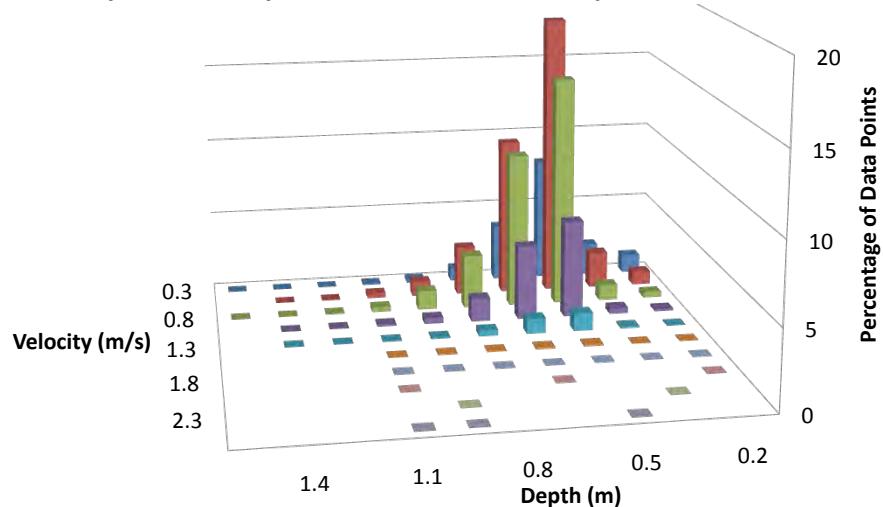
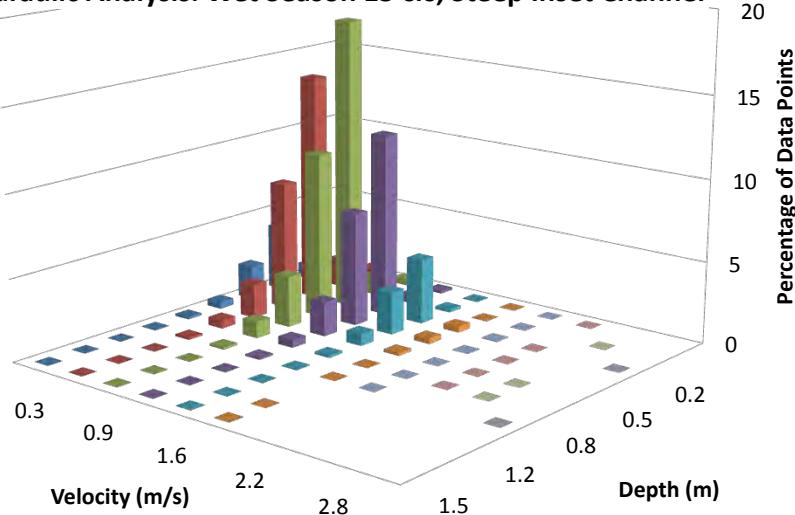
### Hydraulic Analysis: Dry Season 10 cfs, Steep Inset Channel

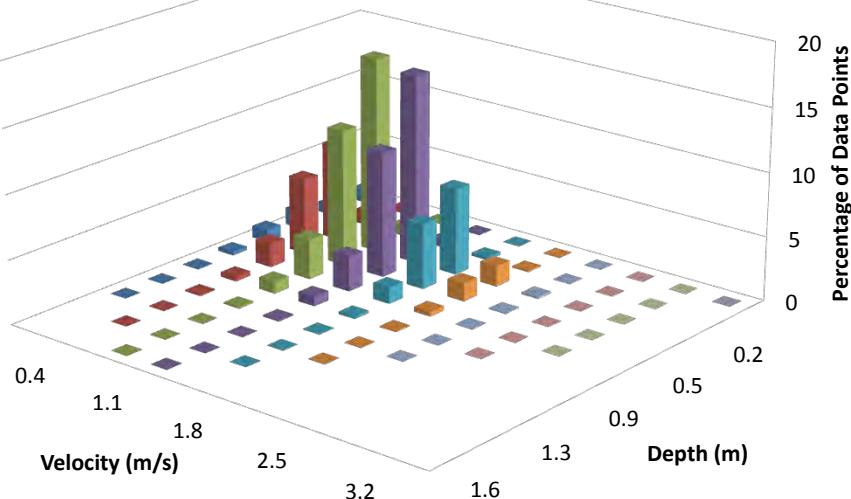
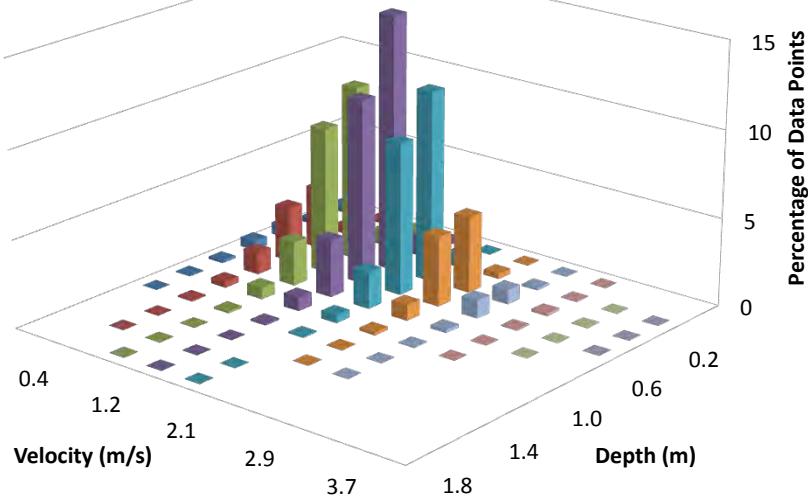


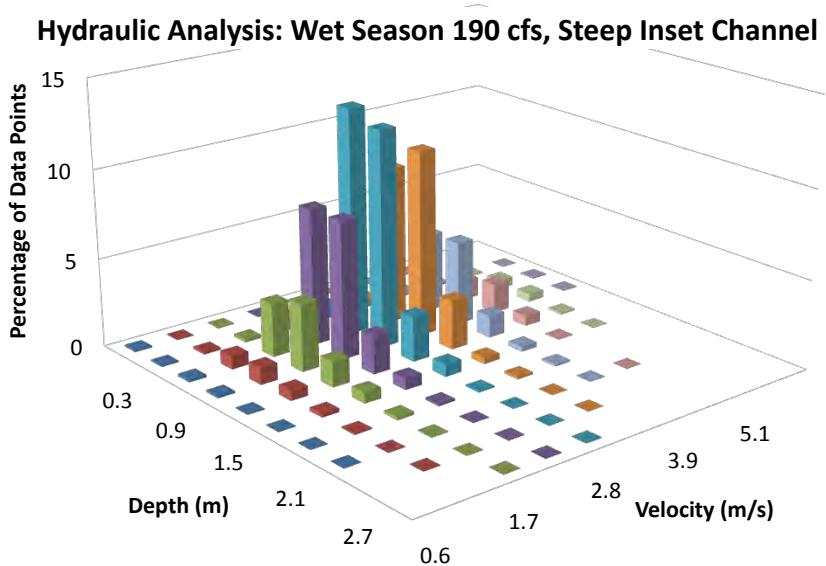
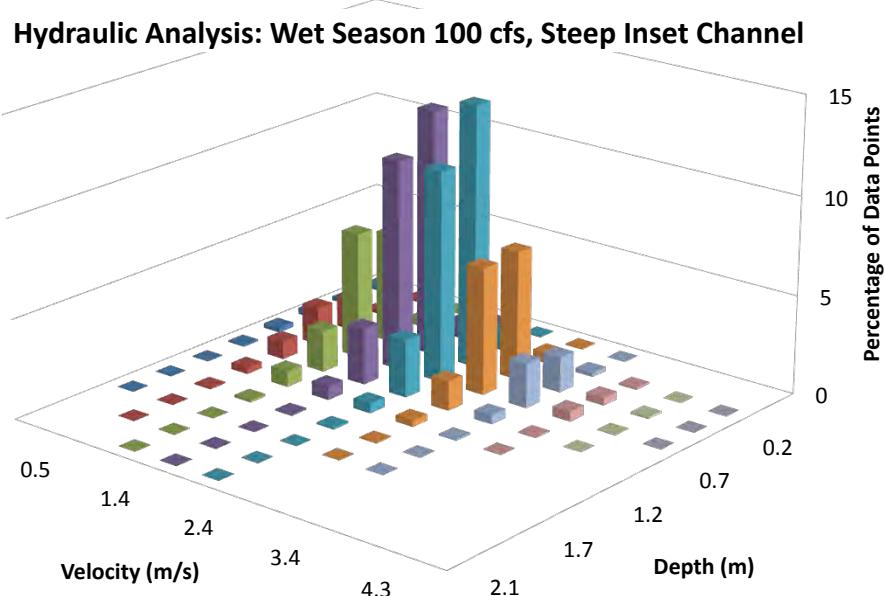
### Hydraulic Analysis: Dry Season 20 cfs, Steep Inset Channel

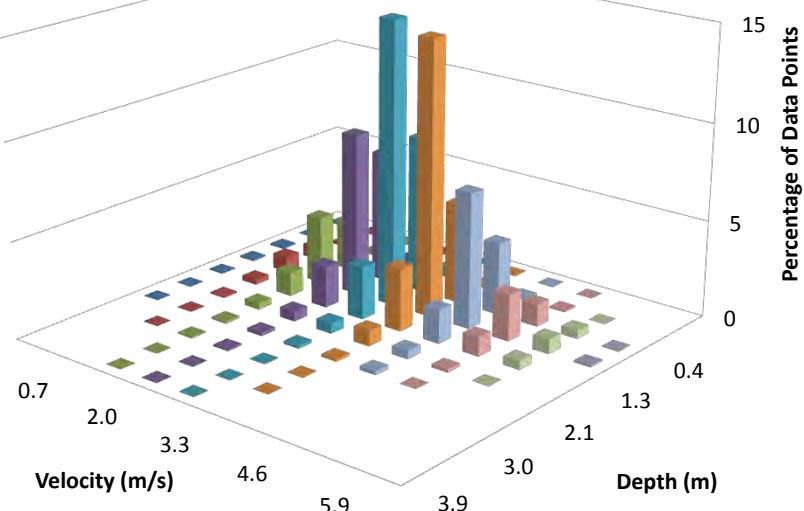
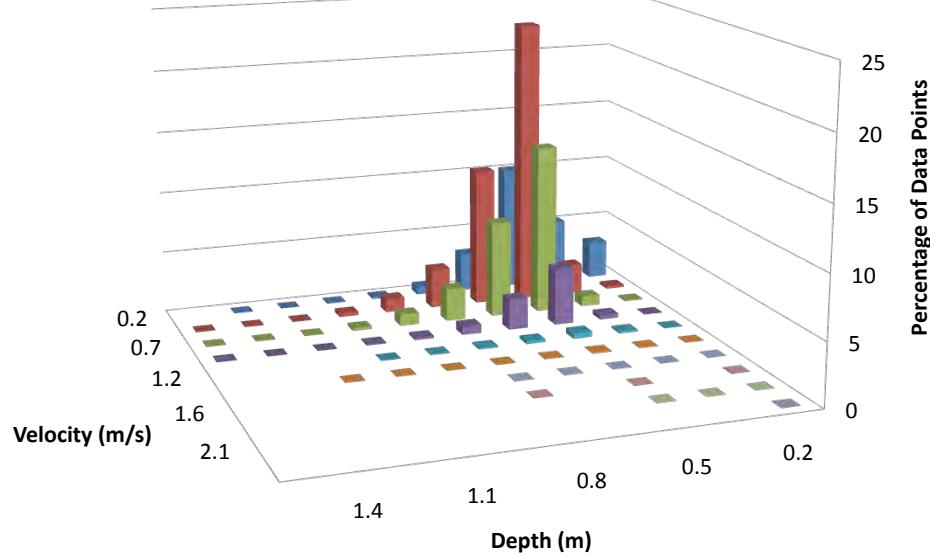


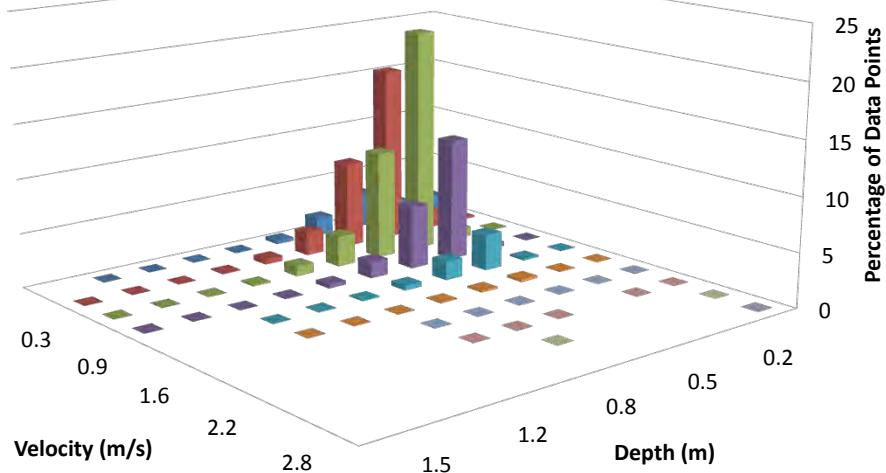
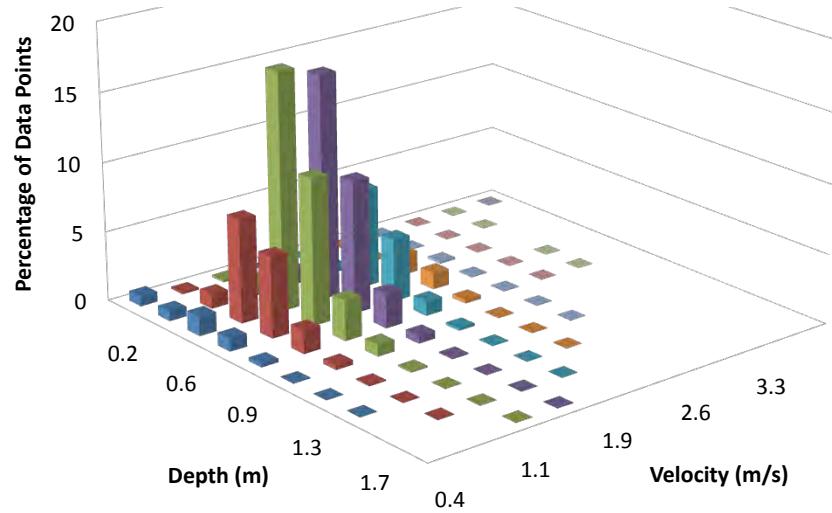
**Hydraulic Analysis: Dry Season 30 cfs, Steep Inset Channel****Hydraulic Analysis: Dry Season 45 cfs, Steep Inset Channel**

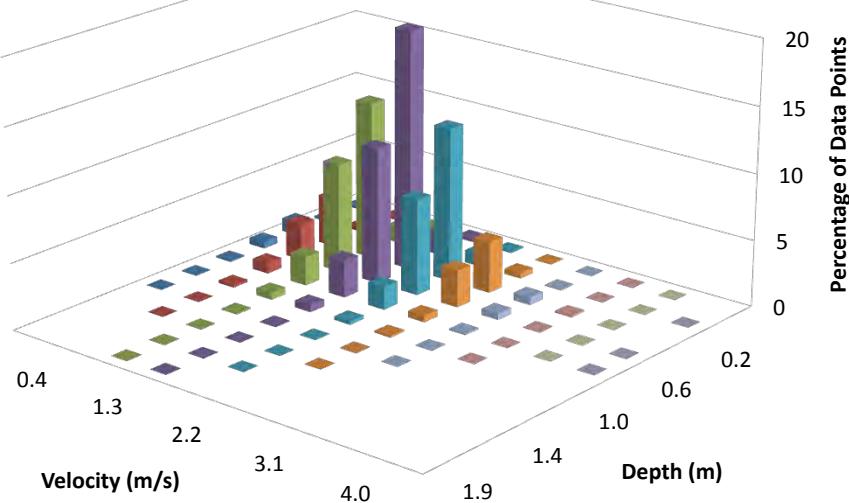
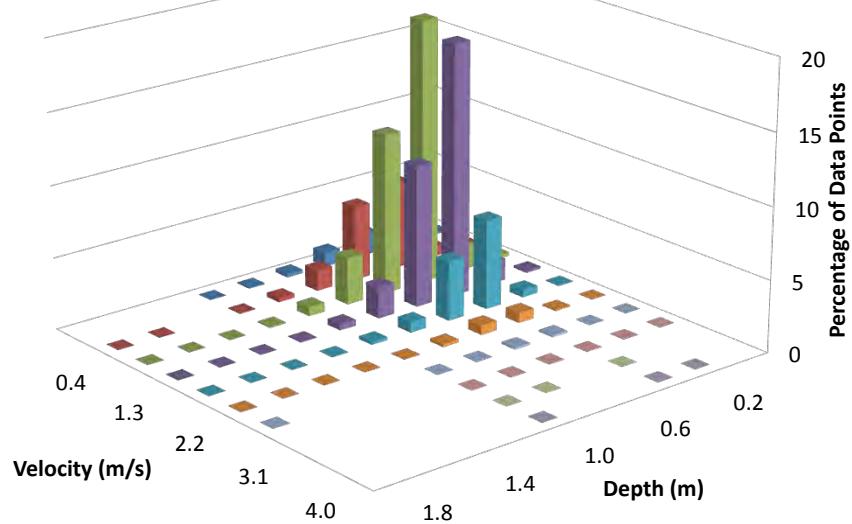
**Hydraulic Analysis: Wet Season 5 cfs, Steep Inset Channel****Hydraulic Analysis: Wet Season 15 cfs, Steep Inset Channel**

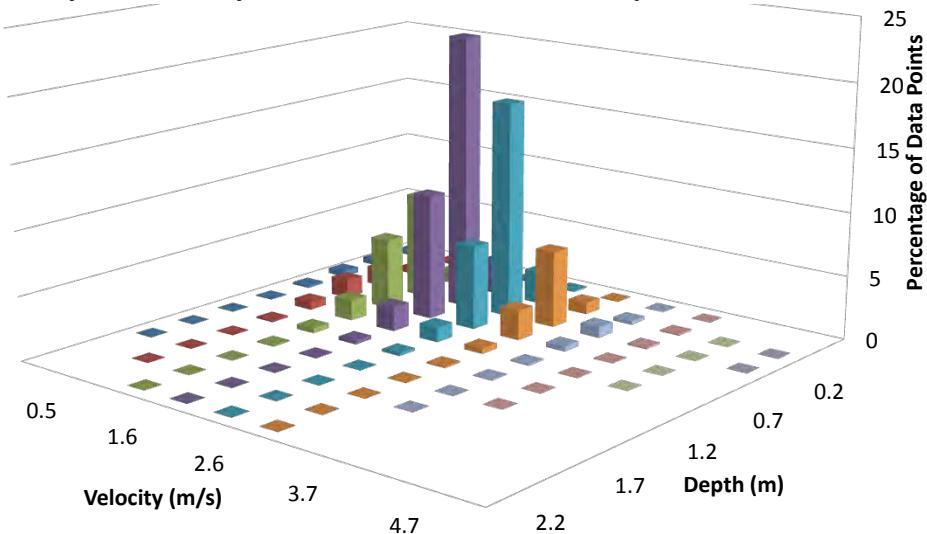
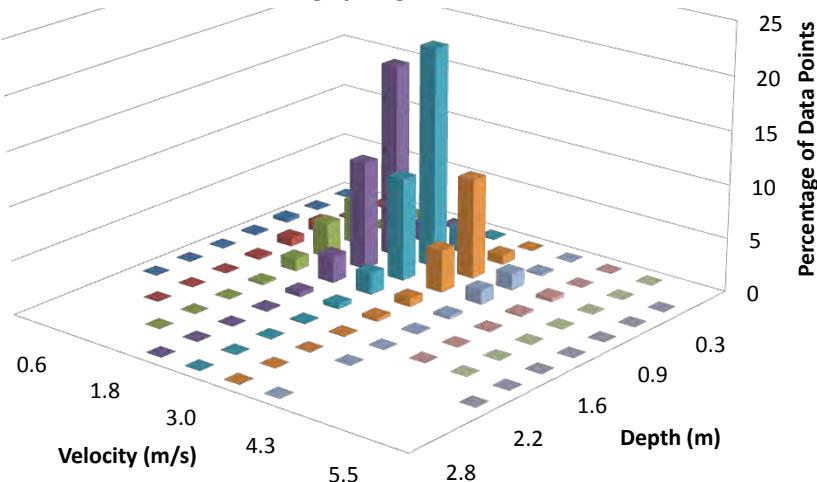
**Hydraulic Analysis: Wet Season 30 cfs, Steep Inset Channel****Hydraulic Analysis: Wet Season 55 cfs, Steep Inset Channel**

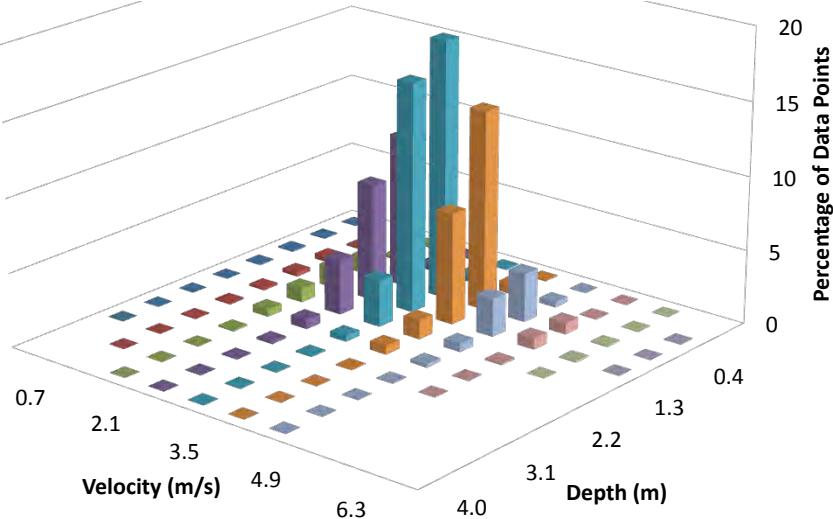
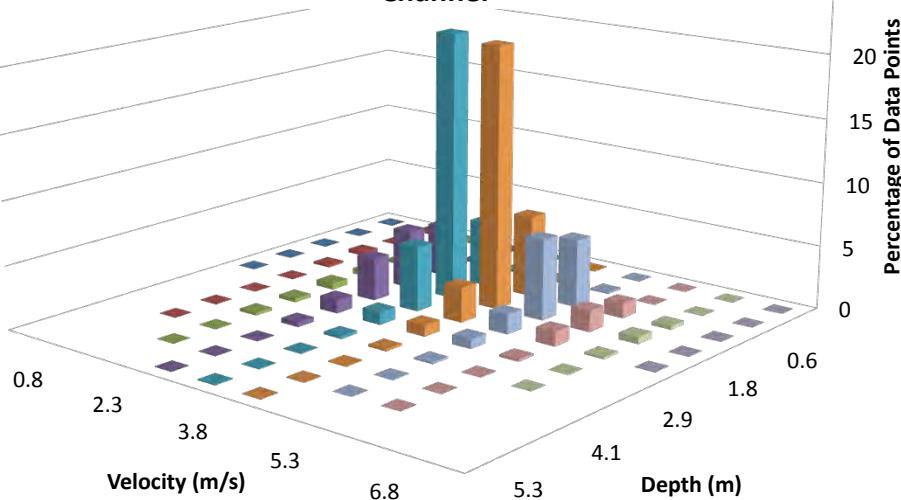


**Hydraulic Analysis: Wet Season 350 cfs, Steep Inset Channel****Hydraulic Analysis: Snow Season 10 cfs, Steep Inset Channel**

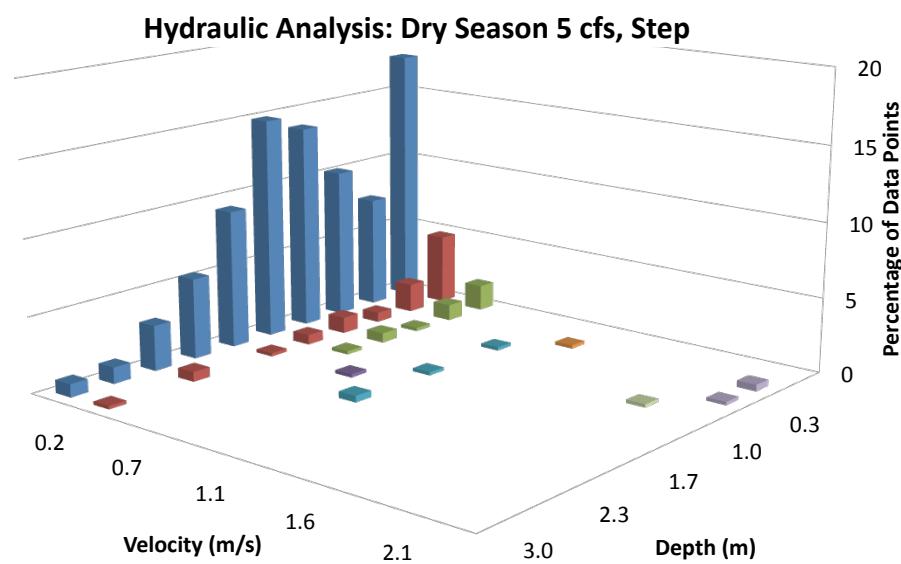
**Hydraulic Analysis: Snow Season 25 cfs, Steep Inset Channel****Hydraulic Analysis: Snow Season 50 cfs, Steep Inset Channel**

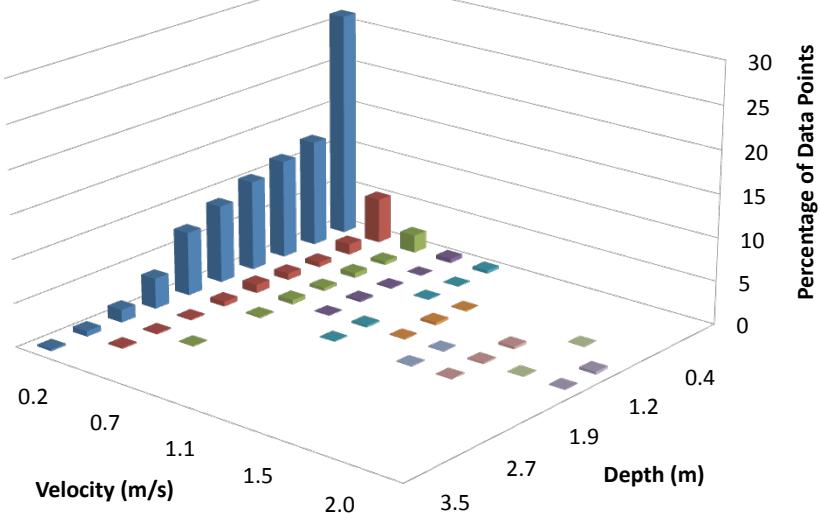
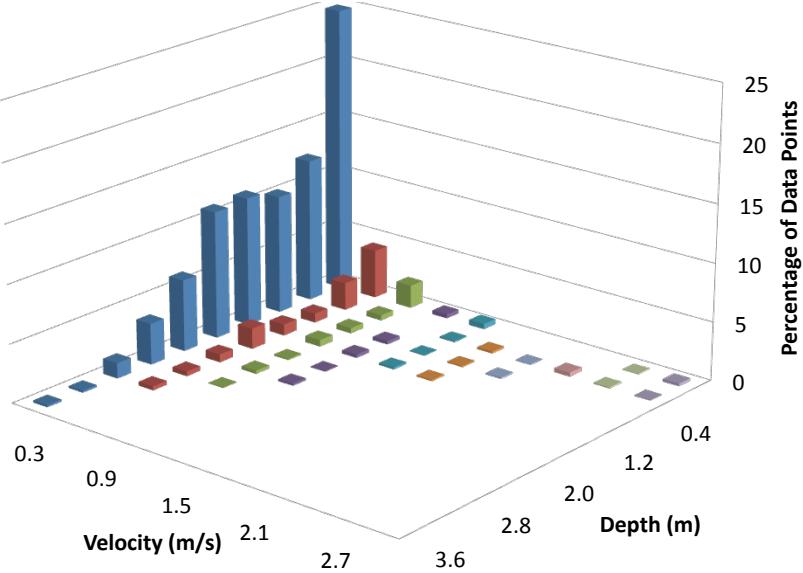
**Hydraulic Analysis: Snow Season 140 cfs, Steep Inset Channel****Hydraulic Analysis: Snow Season 210 cfs, Steep Inset Channel**

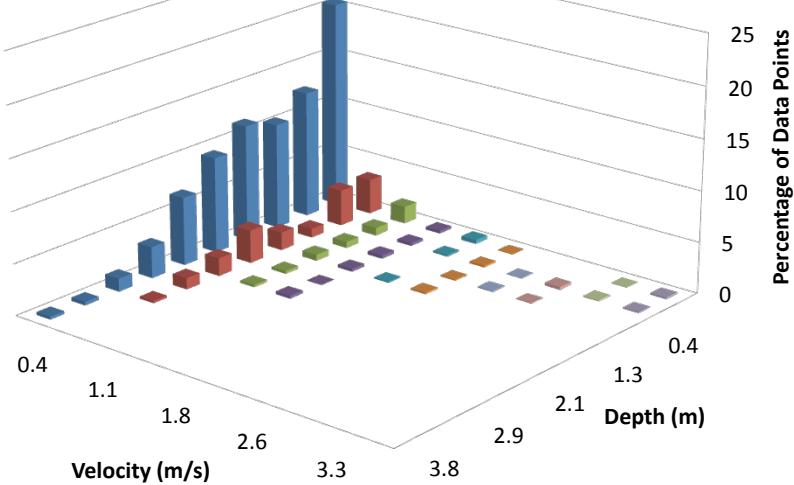
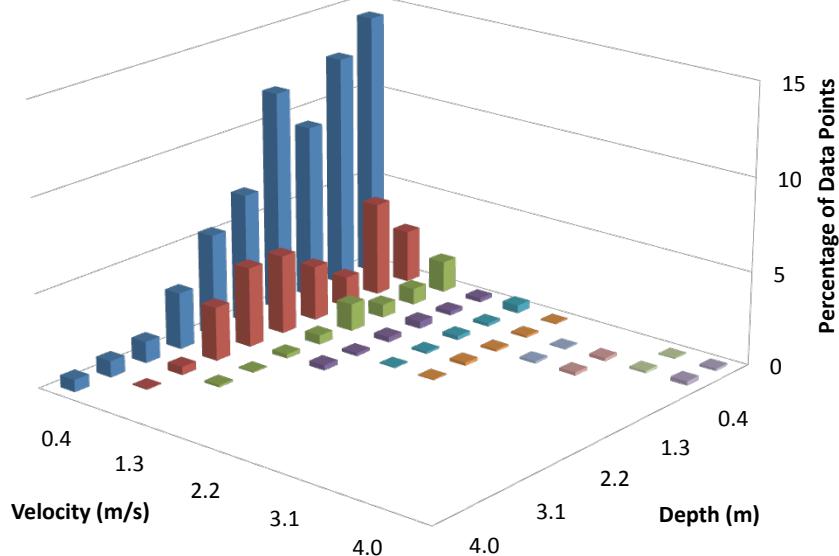
**Hydraulic Analysis: Snow Season 525 cfs, Steep Inset Channel****Hydraulic Analysis: Snow Season 1103 cfs, Steep Inset Channel**

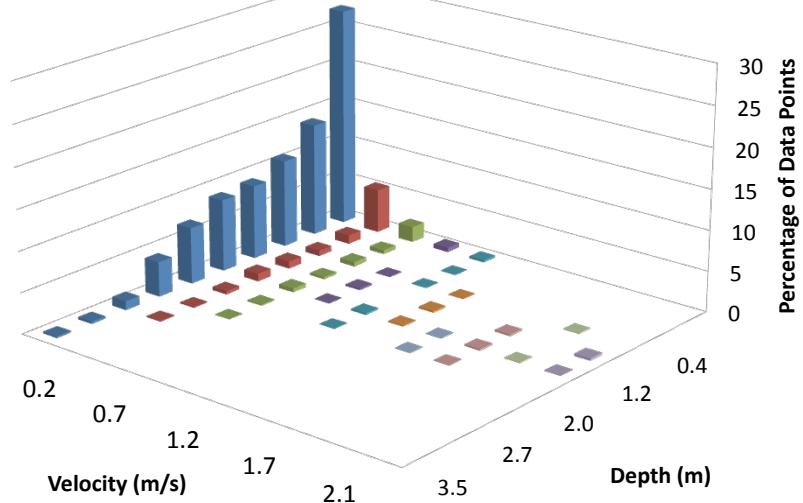
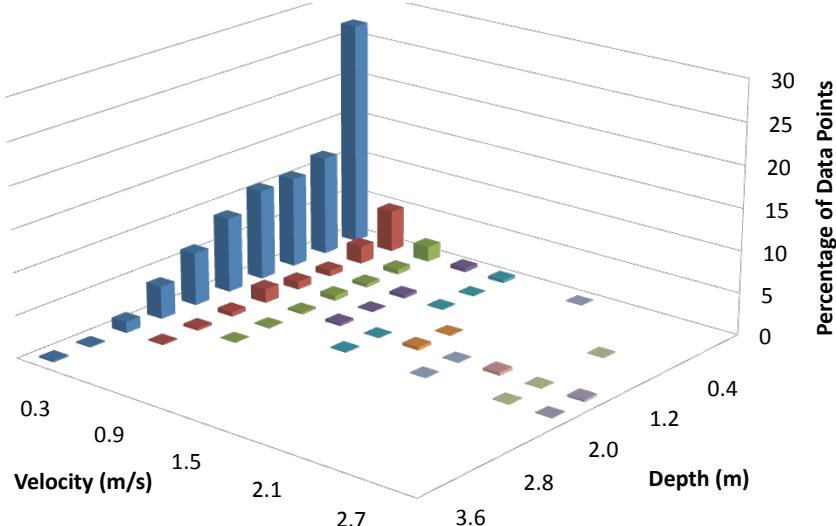
**Hydraulic Analysis: Snow Season 3000 cfs, Steep Inset****Channel****Hydraulic Analysis: Snow Season 6921 cfs, Steep Inset****Channel**

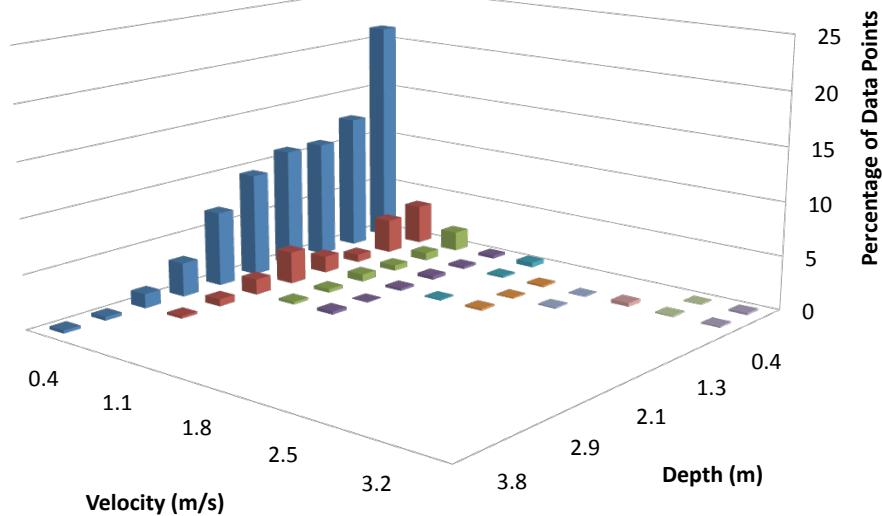
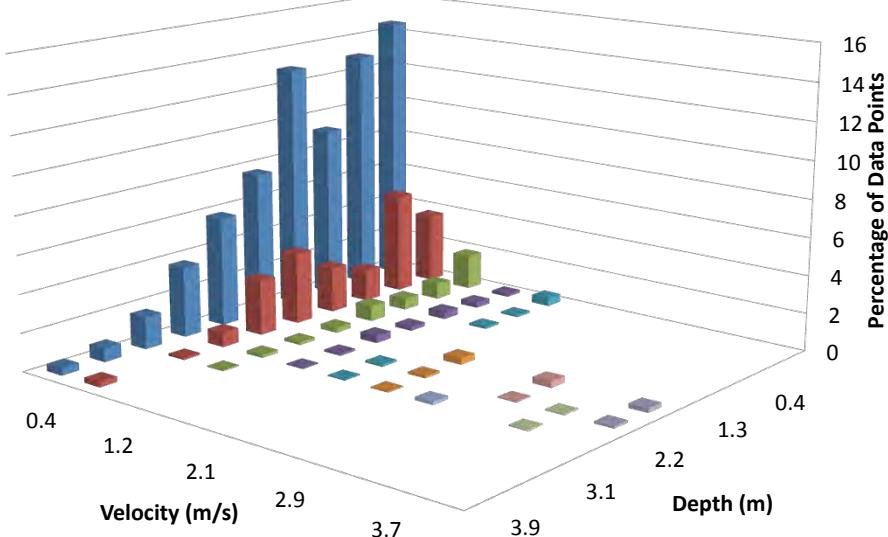
3D joint depth-velocity distributions  
across all flows and seasons,  
stratified by step morphologic units

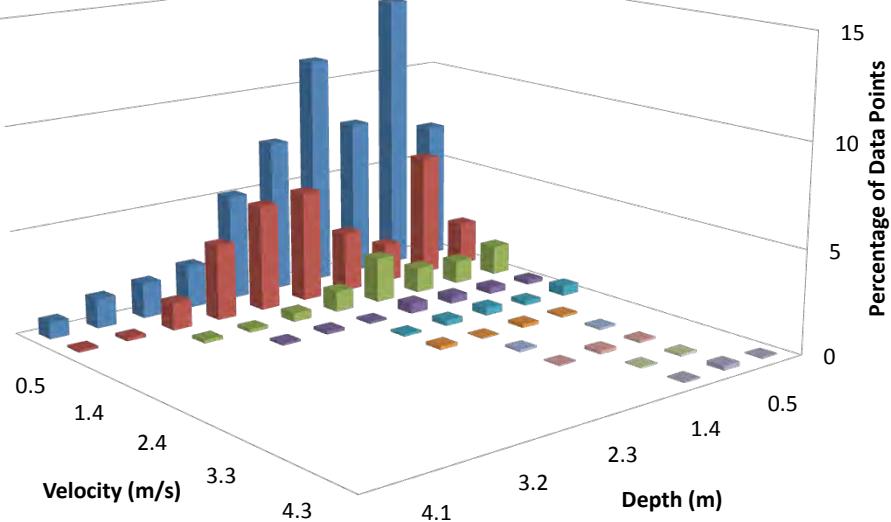
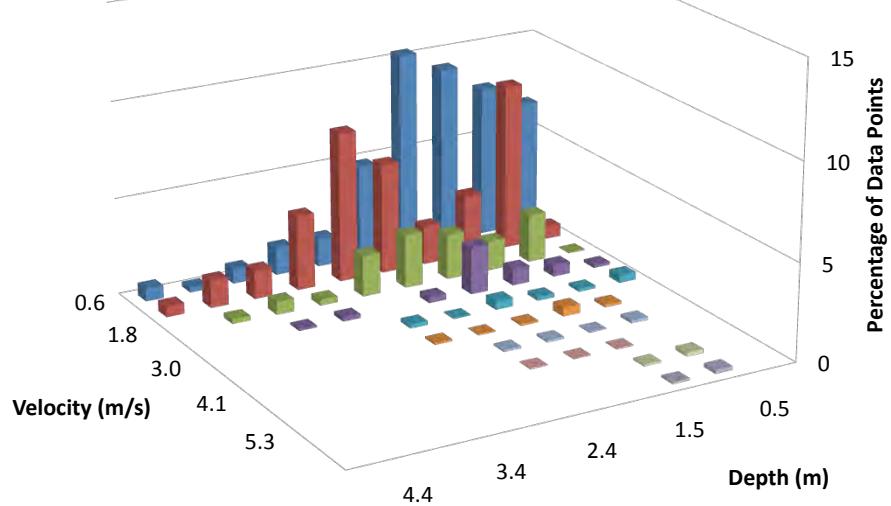


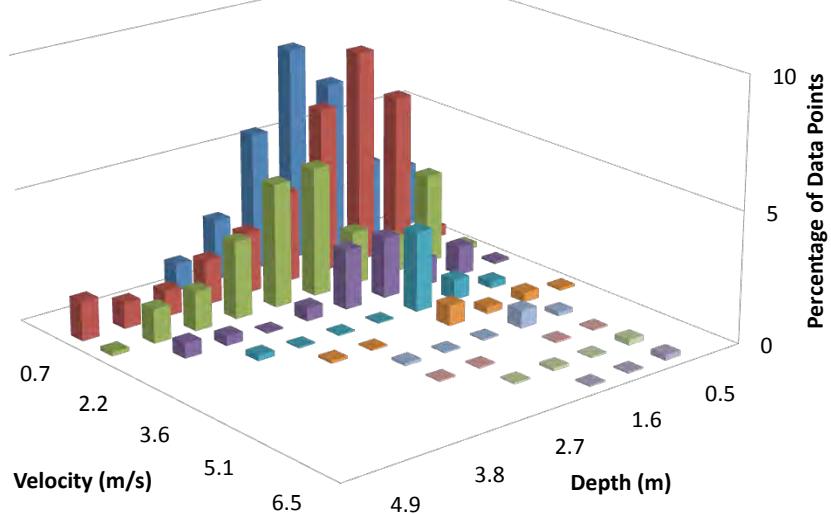
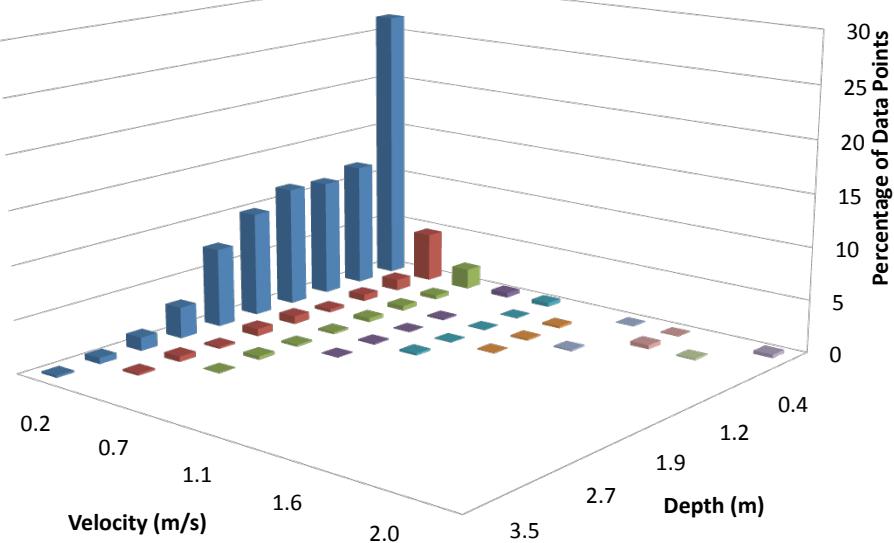
**Hydraulic Analysis: Dry Season 10 cfs, Step****Hydraulic Analysis: Dry Season 20 cfs, Step**

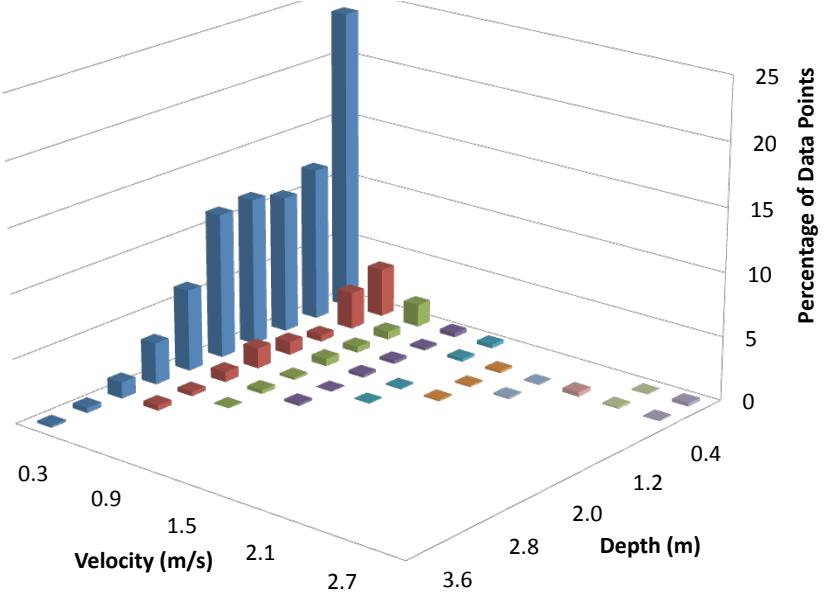
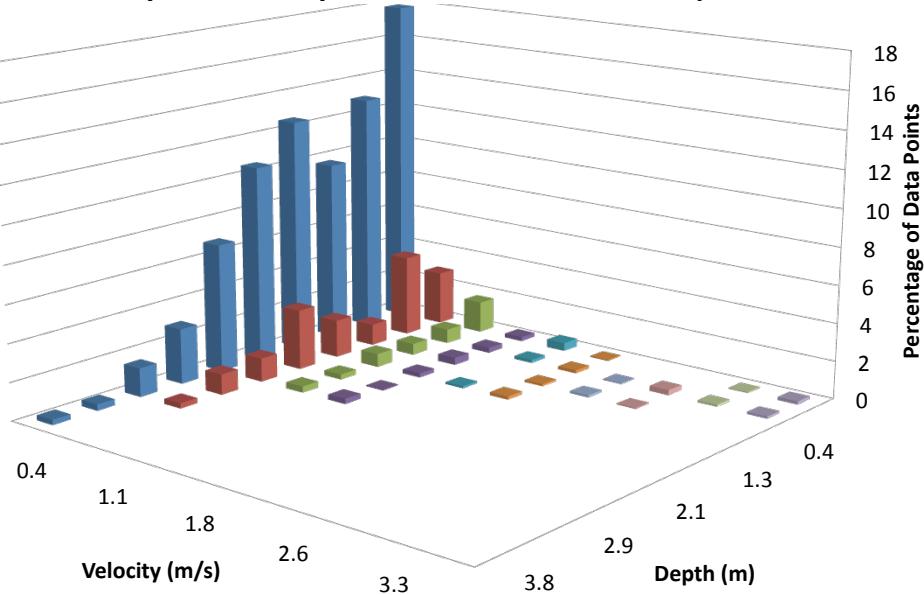
**Hydraulic Analysis: Dry Season 30 cfs, Step****Hydraulic Analysis: Dry Season 45 cfs, Step**

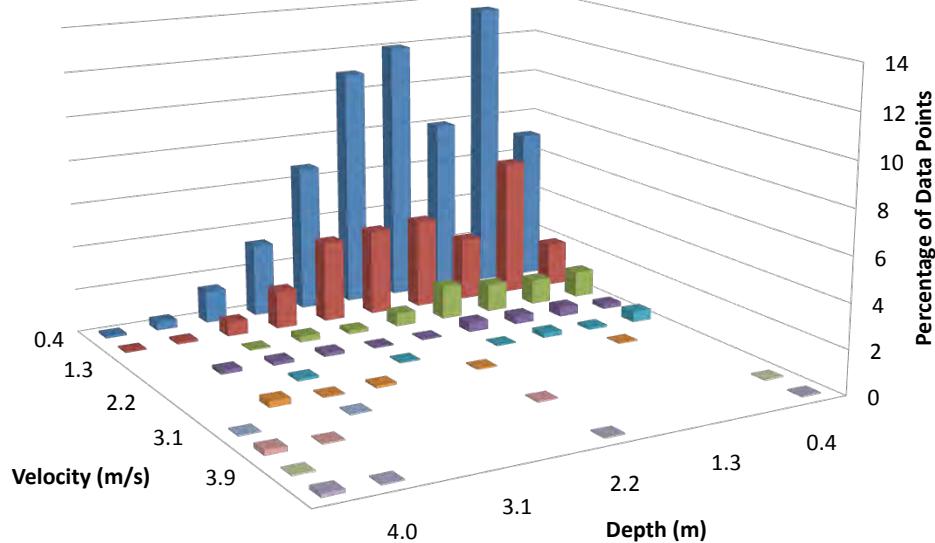
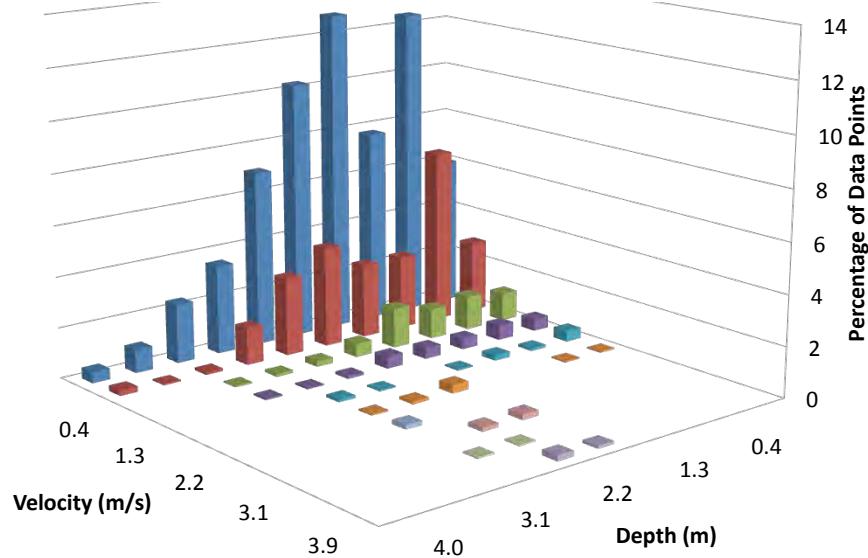
**Hydraulic Analysis: Wet Season 5 cfs, Step****Hydraulic Analysis: Wet Season 15 cfs, Step**

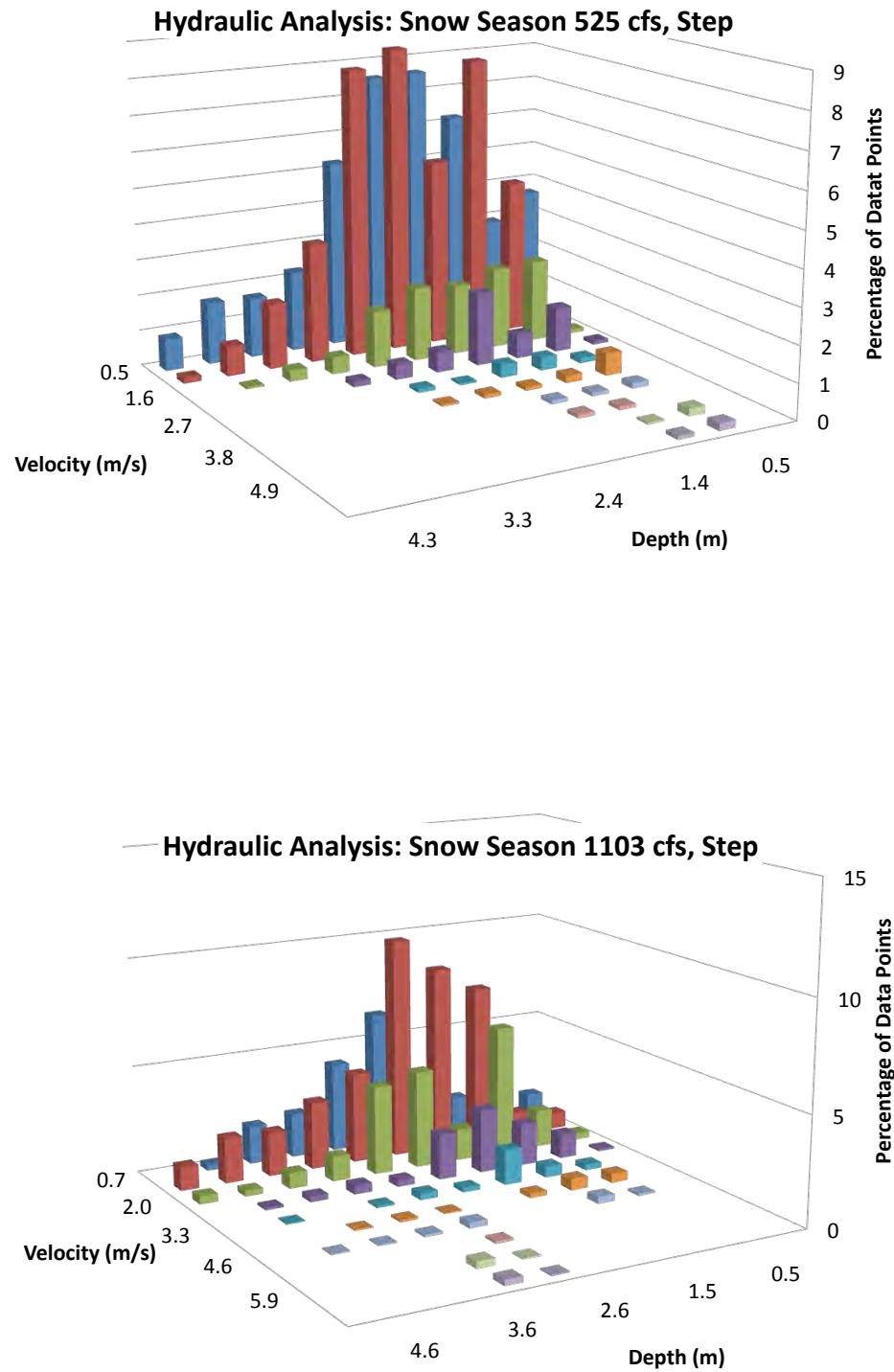
**Hydraulic Analysis: Wet Season 30 cfs, Step****Hydraulic Analysis: Wet Season 55 cfs, Step**

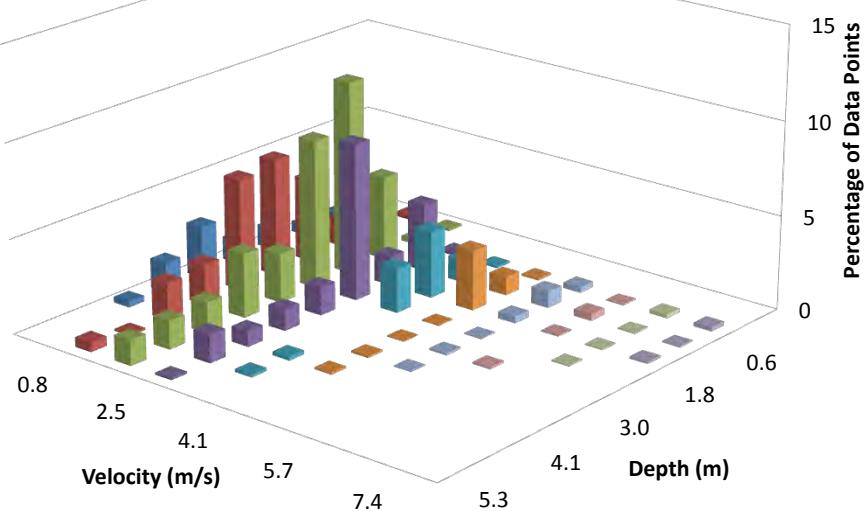
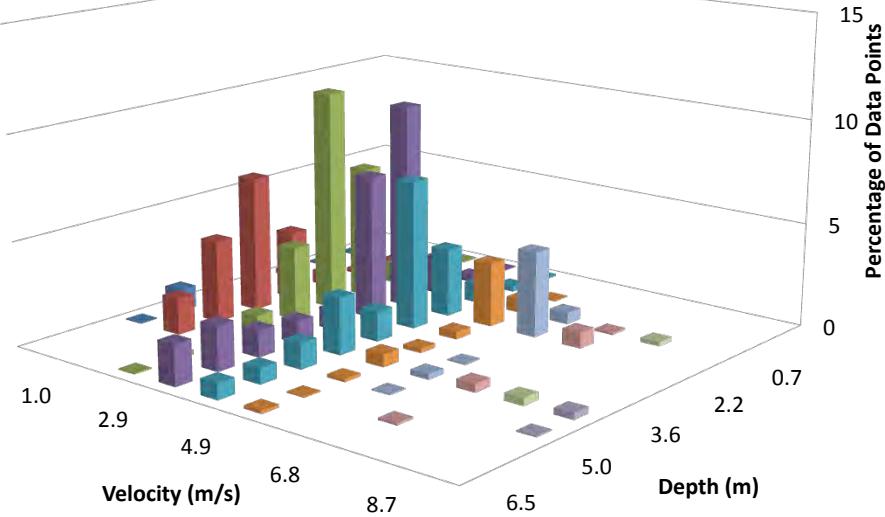
**Hydraulic Analysis: Wet Season 100 cfs, Step****Hydraulic Analysis: Wet Season 190 cfs, Step**

**Hydraulic Analysis: Wet Season 350 cfs, Step****Hydraulic Analysis: Snow Season 10 cfs, Step**

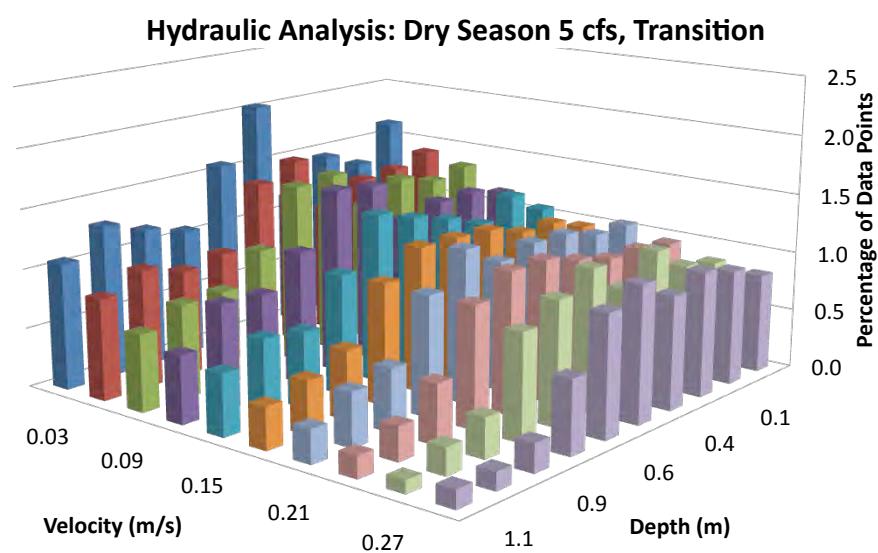
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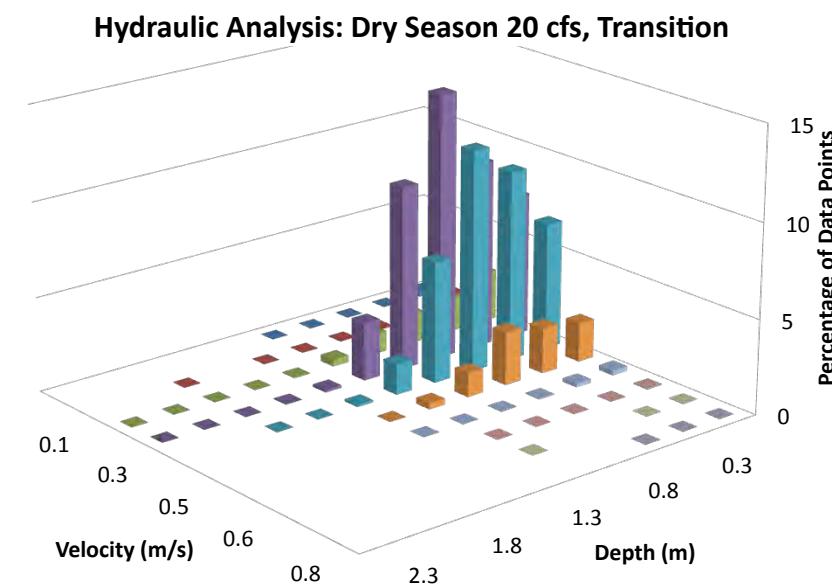
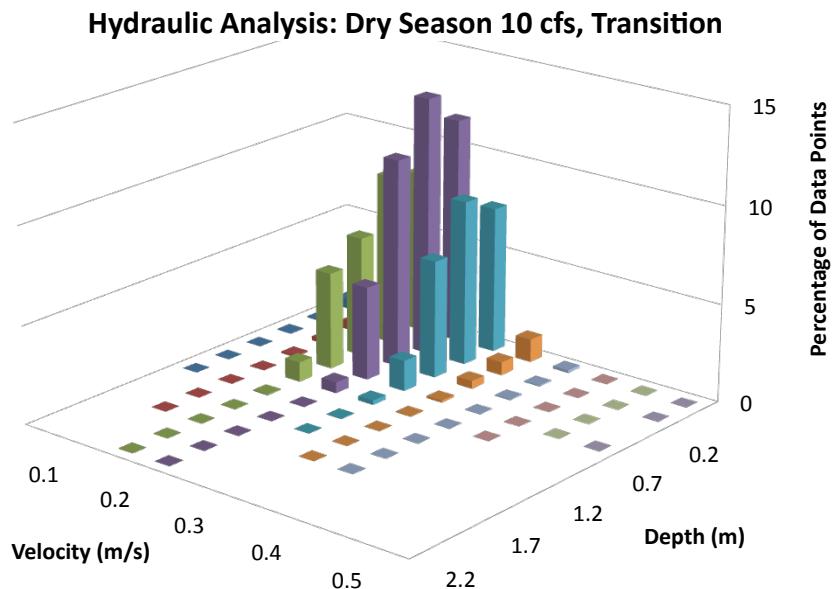
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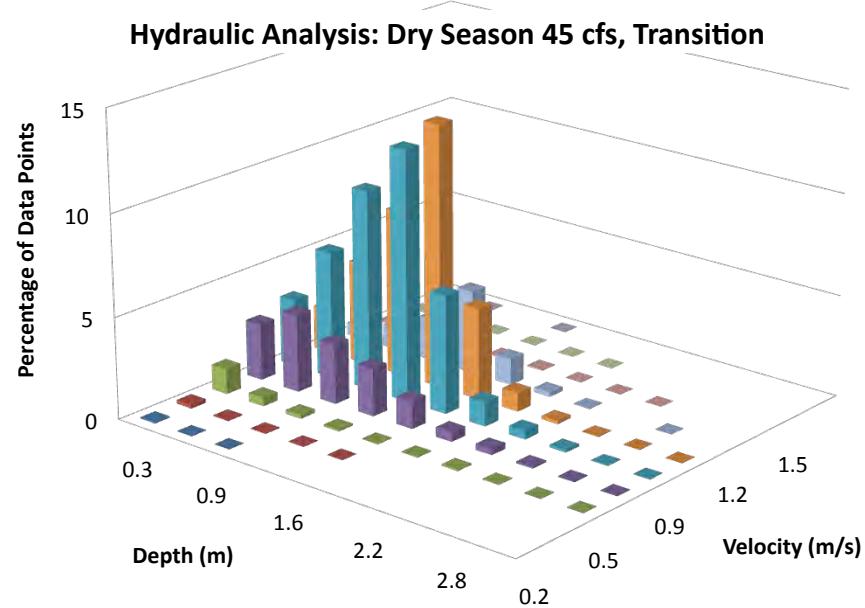
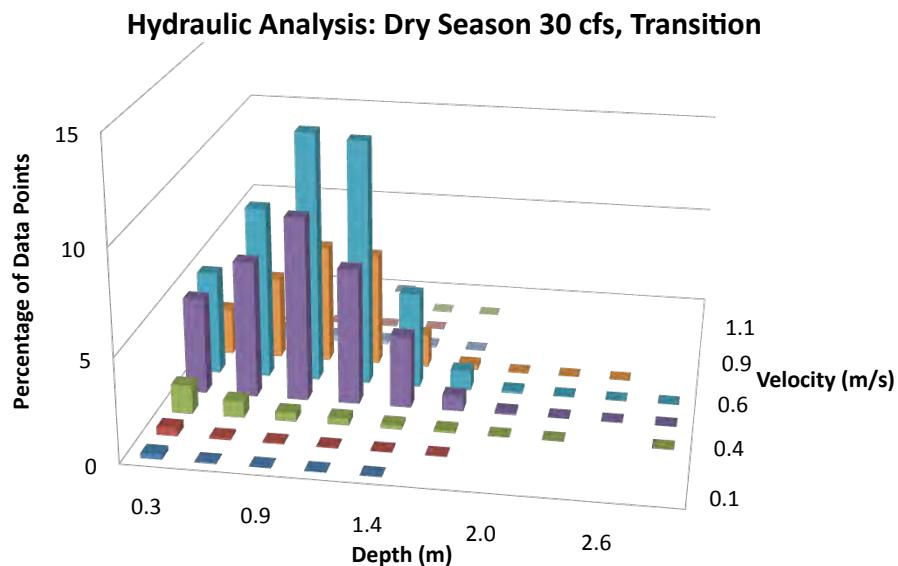


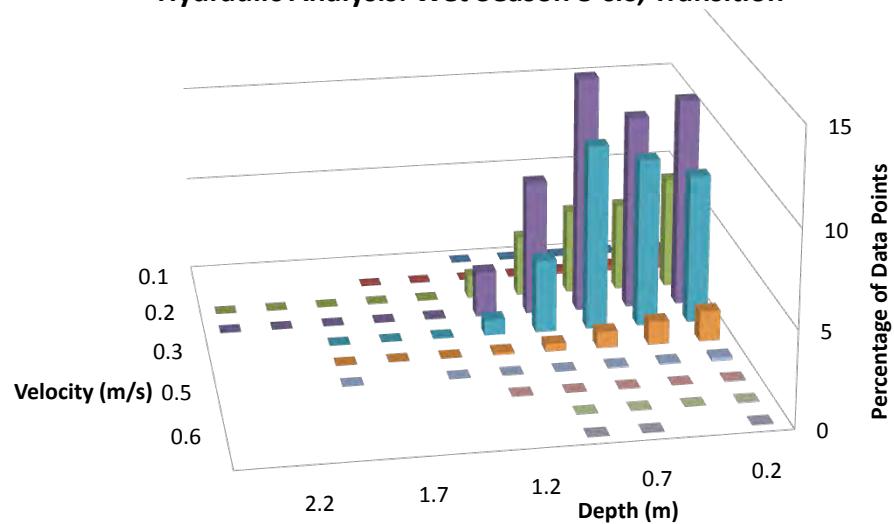
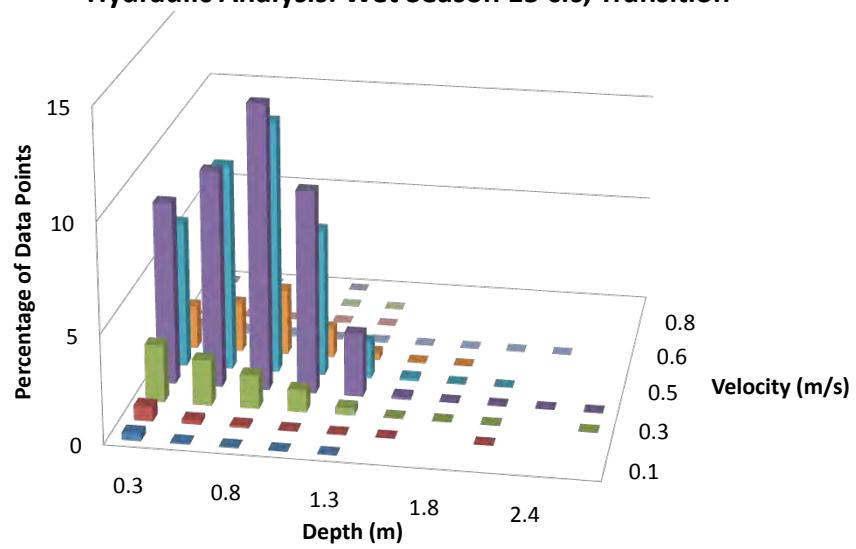
**Hydraulic Analysis: Snow Season 3000 cfs, Step****Hydraulic Analysis: Snow Season 6921 cfs, Step**

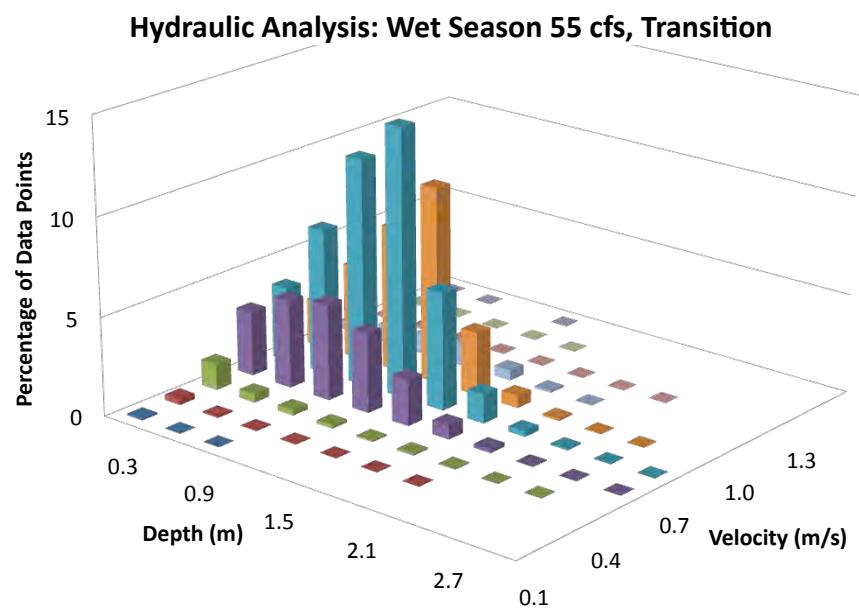
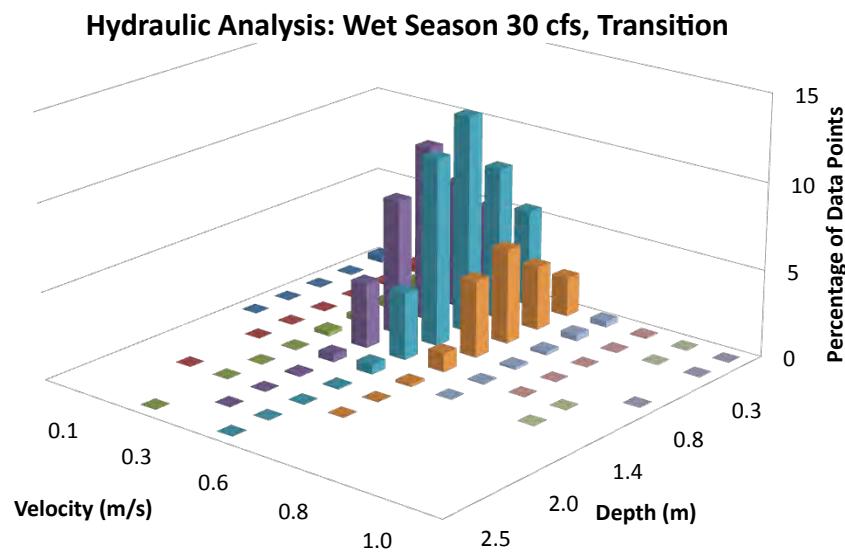
3D joint depth-velocity distributions  
across all flows and seasons,  
stratified by transition morphologic  
units

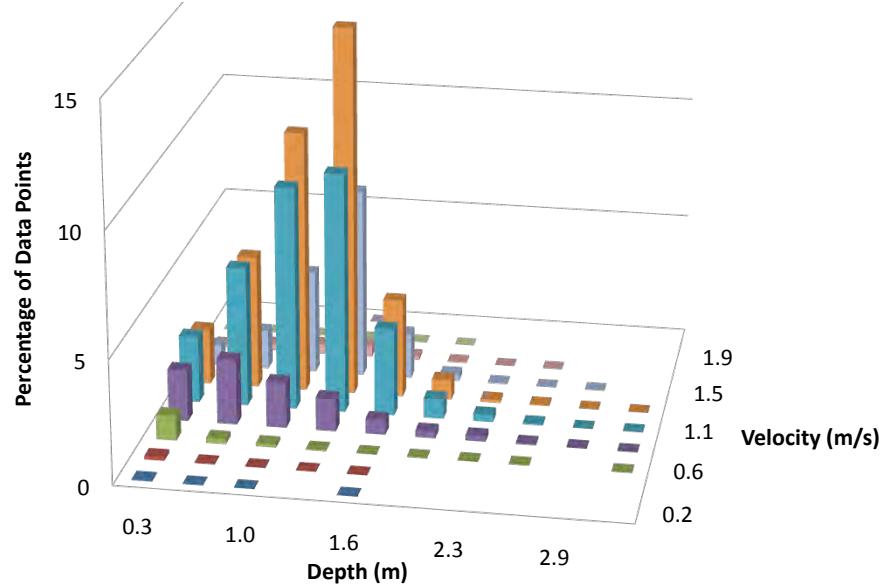
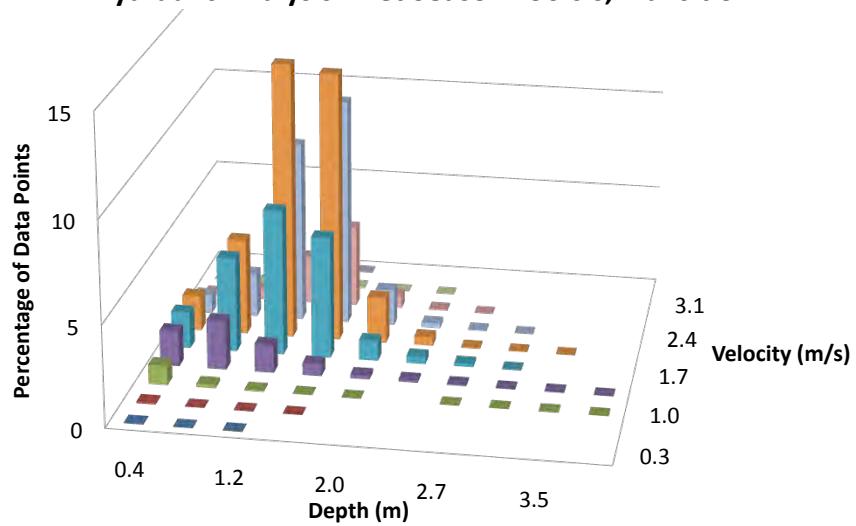


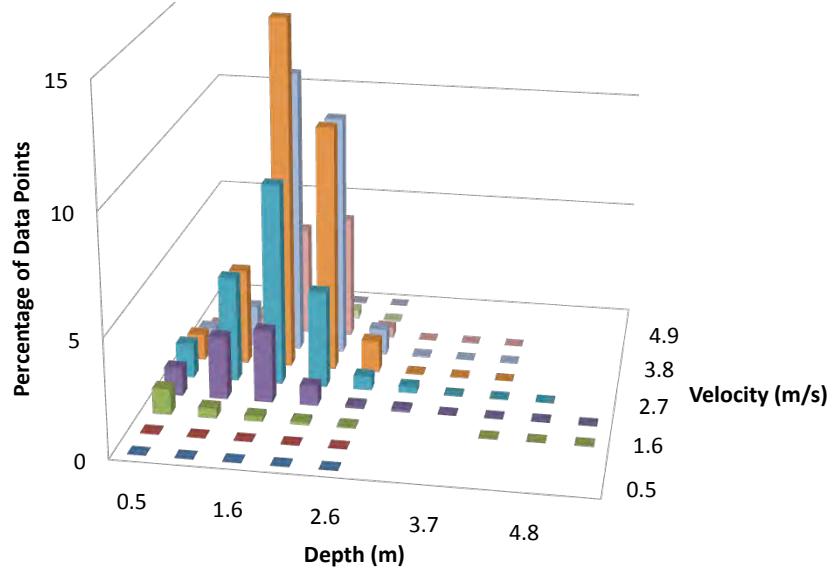
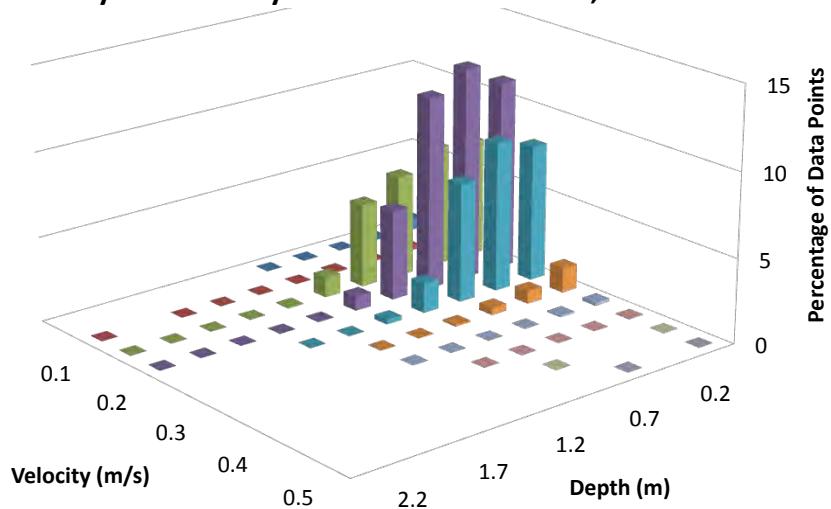




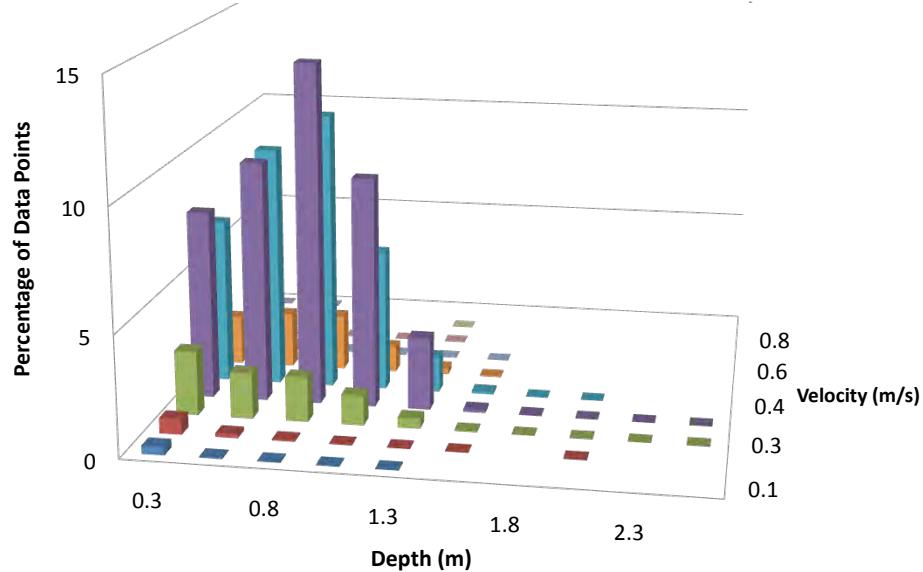
**Hydraulic Analysis: Wet Season 5 cfs, Transition****Hydraulic Analysis: Wet Season 15 cfs, Transition**



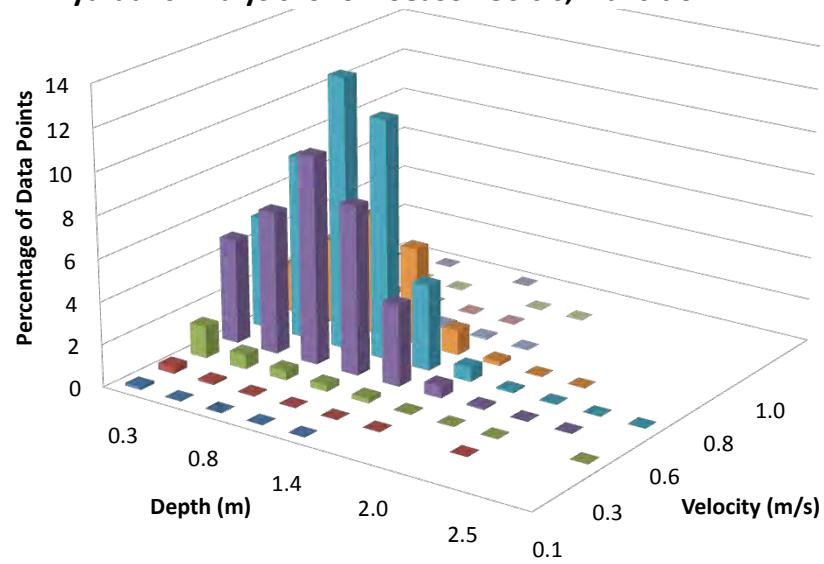
**Hydraulic Analysis: Wet Season 100 cfs, Transition****Hydraulic Analysis: Wet Season 190 cfs, Transition**

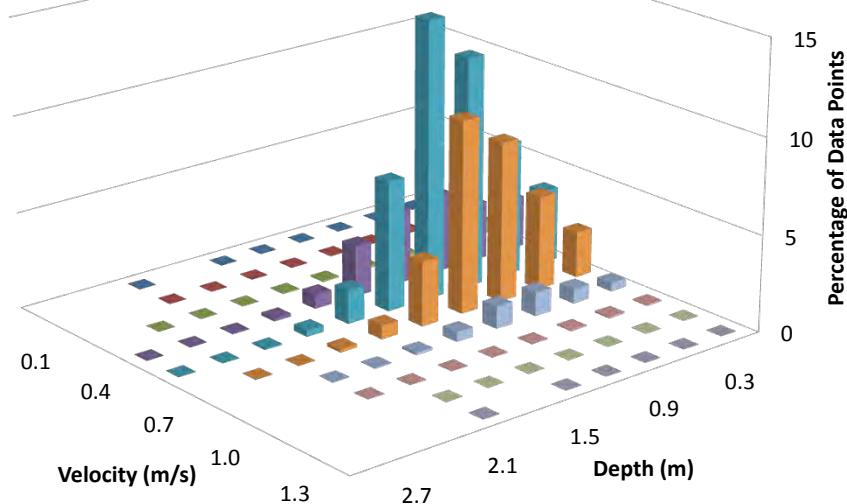
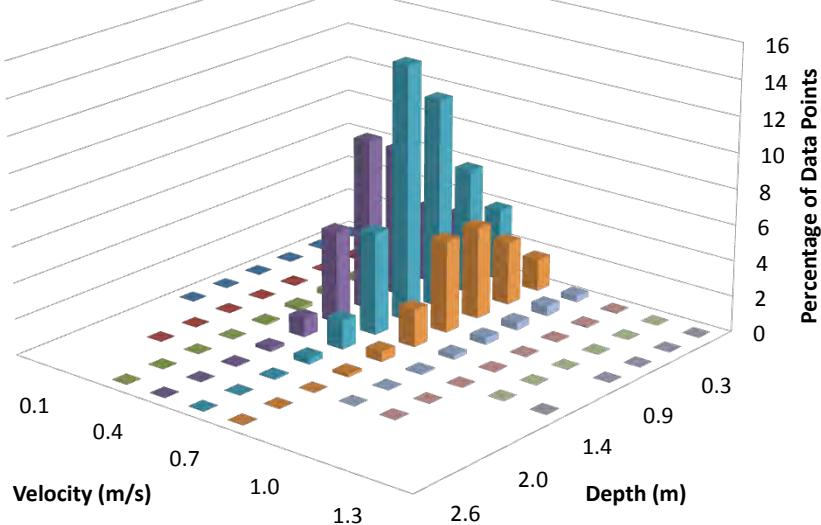
**Hydraulic Analysis: Wet Season 350 cfs, Transition****Hydraulic Analysis: Snow Season 10 cfs, Transition**

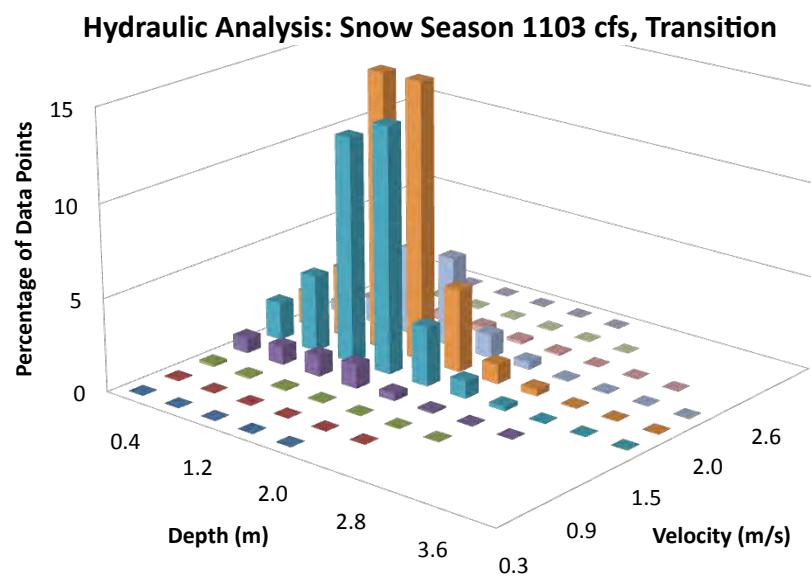
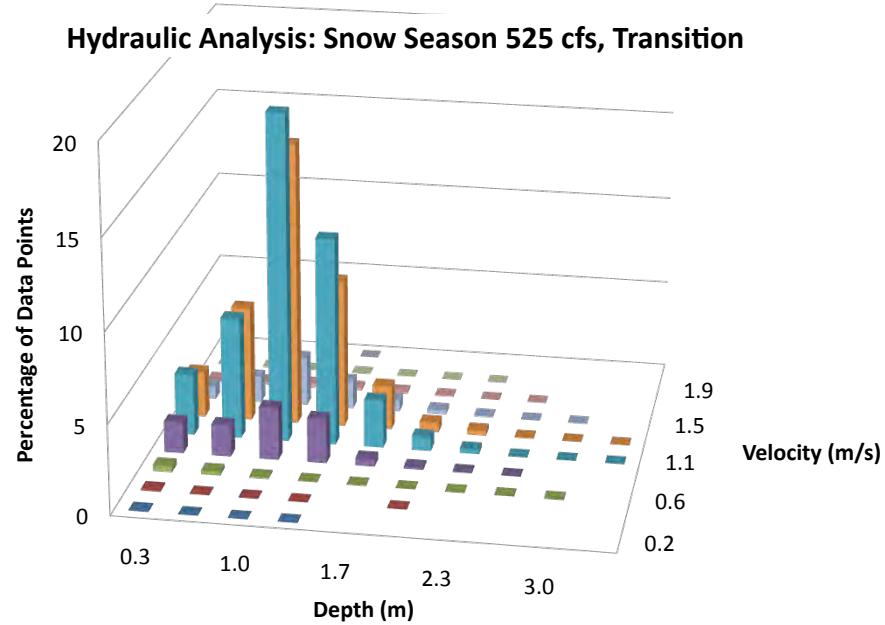
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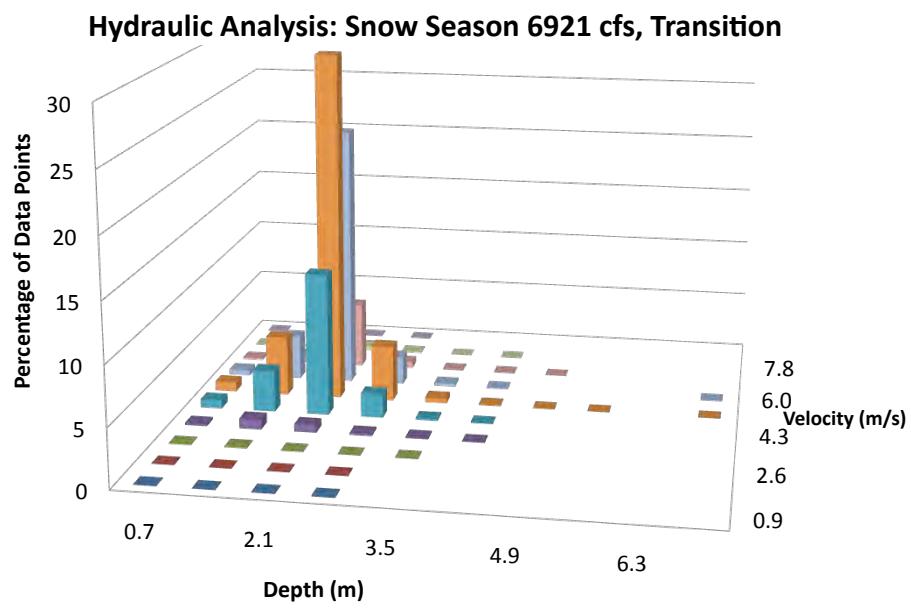
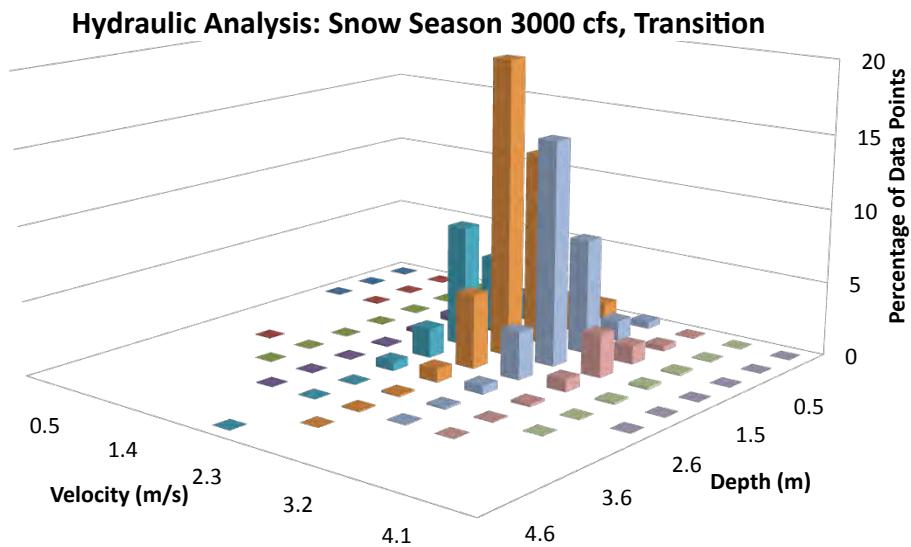


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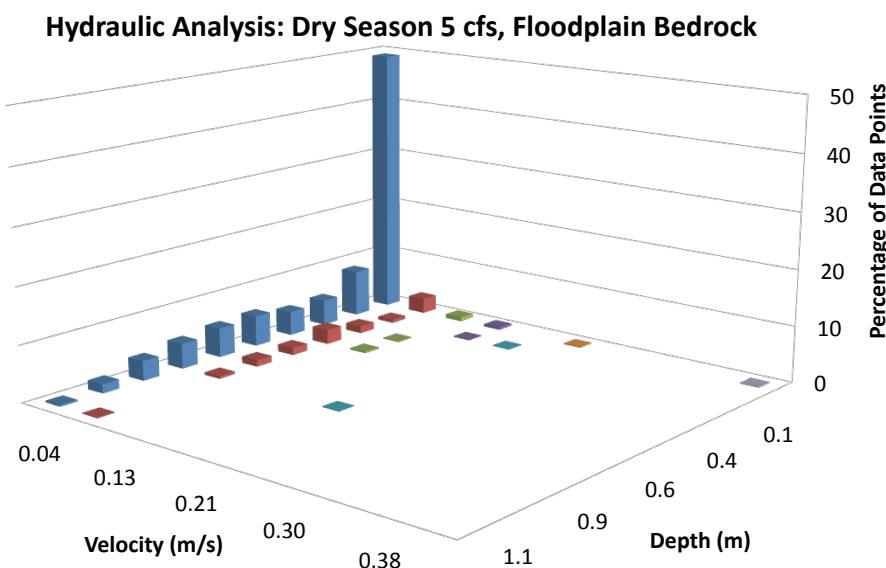


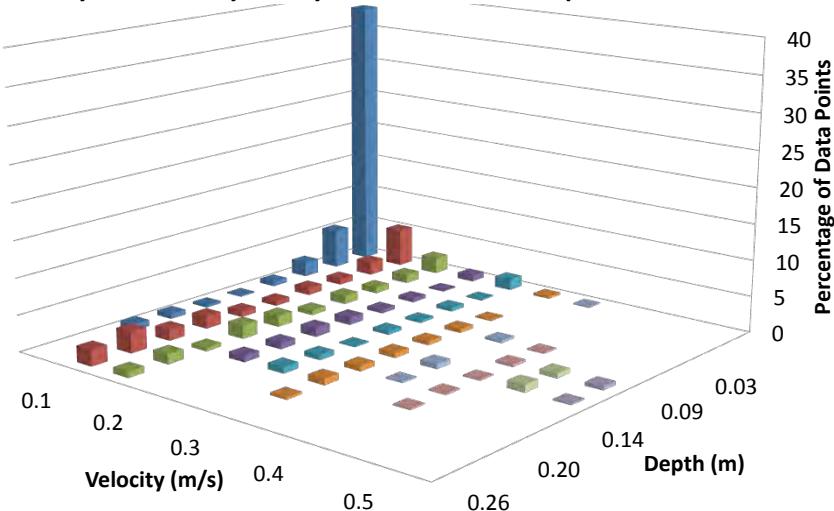
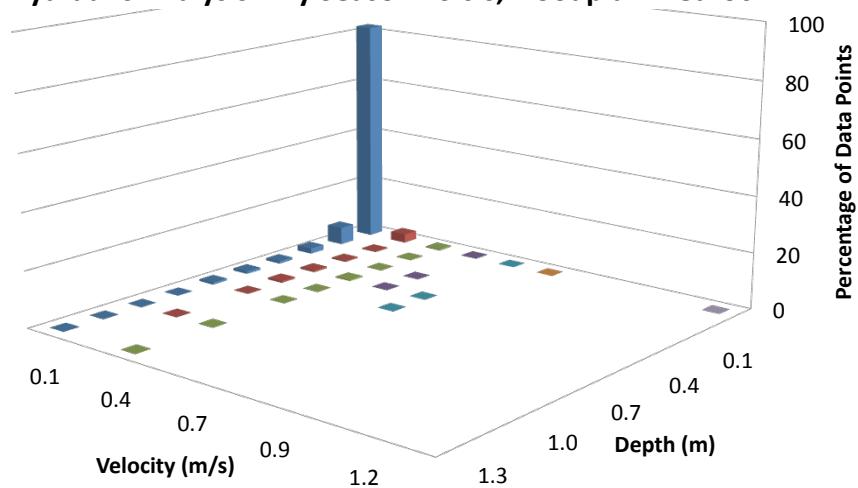
**Hydraulic Analysis: Snow Season 140 cfs, Transition****Hydraulic Analysis: Snow Season 210 cfs, Transition**

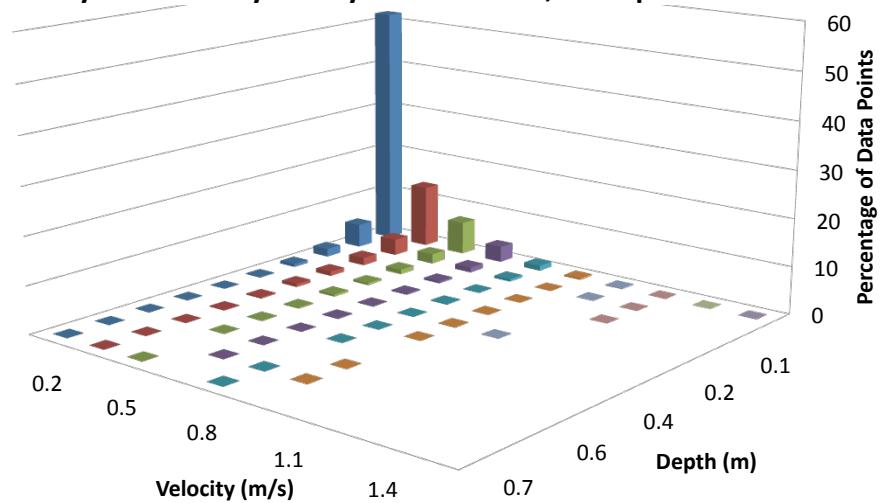
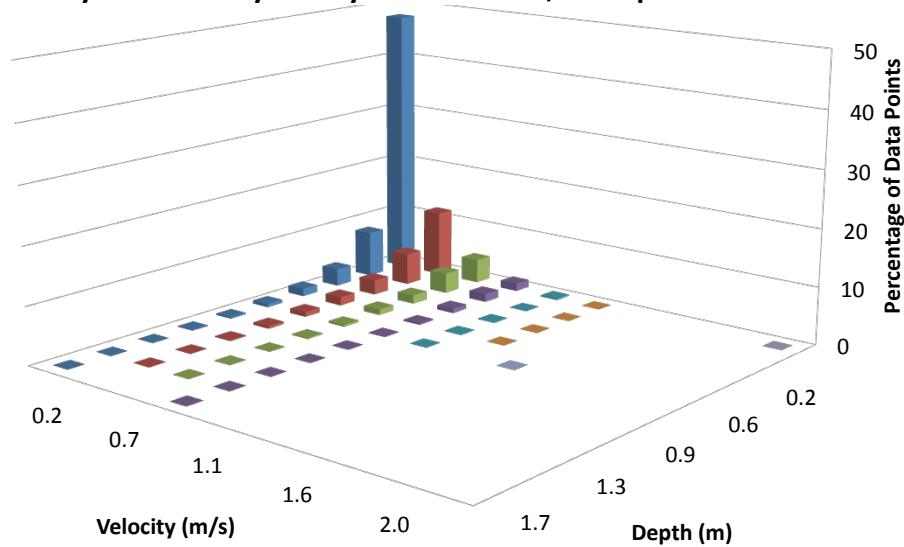


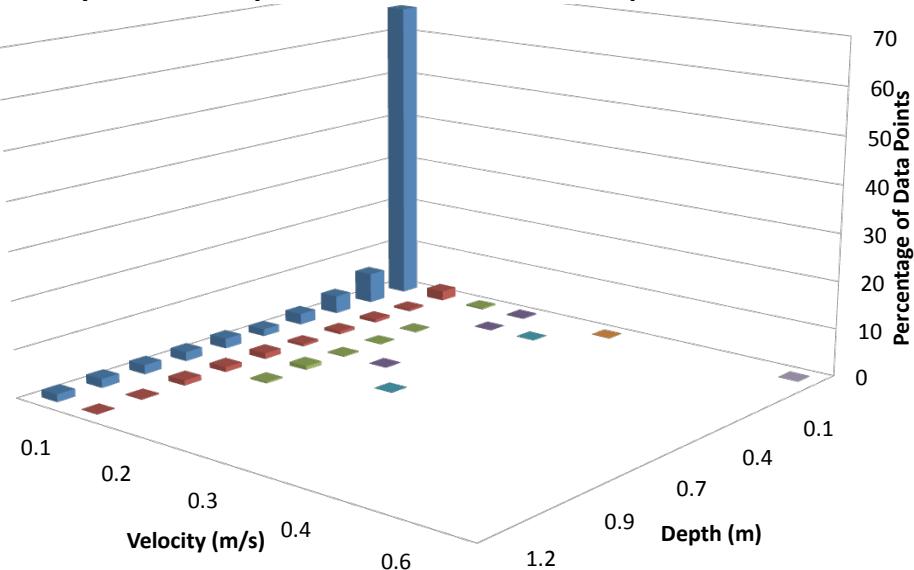
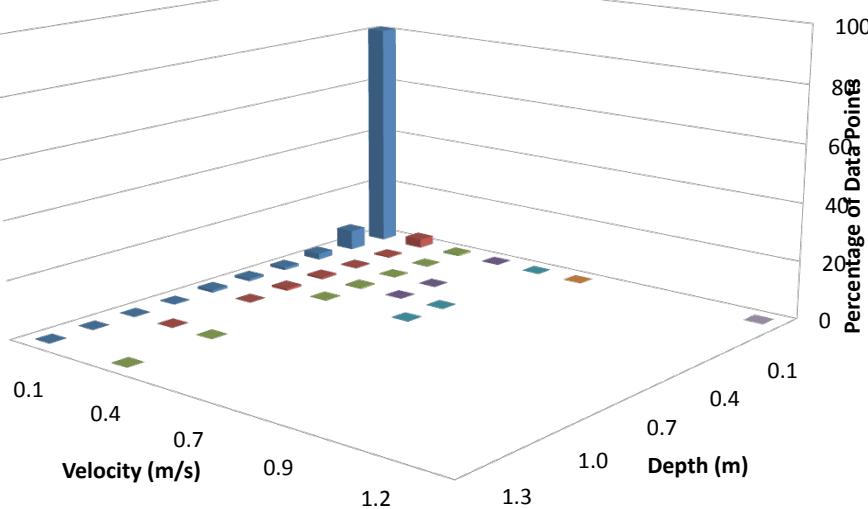


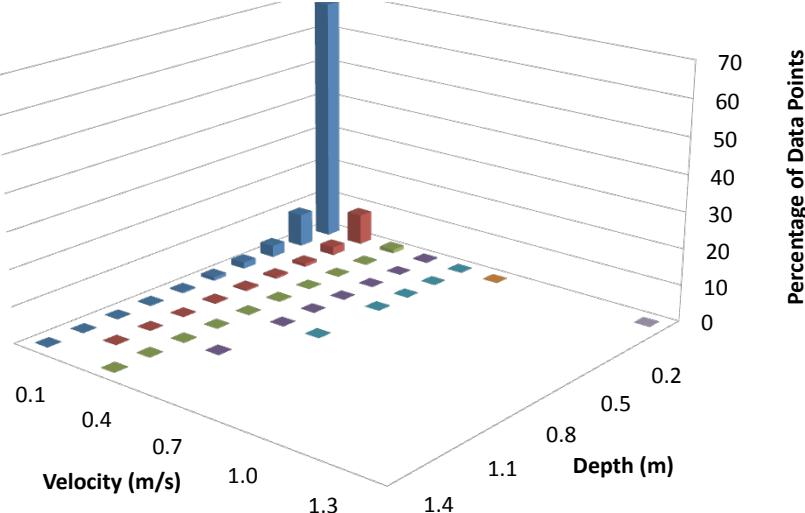
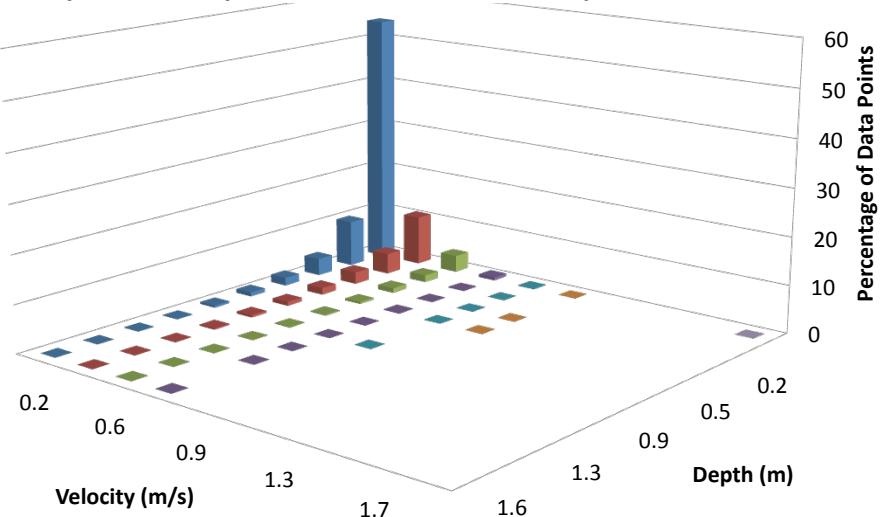
3D joint depth-velocity distributions  
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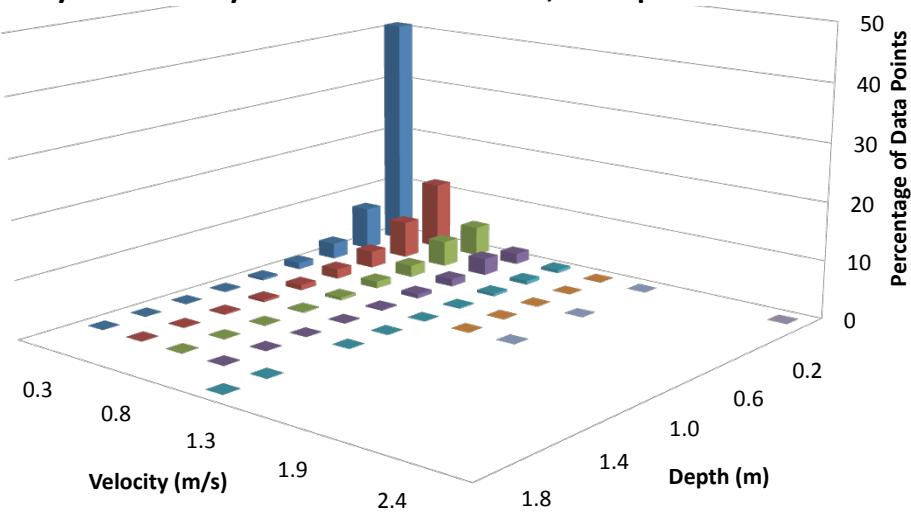
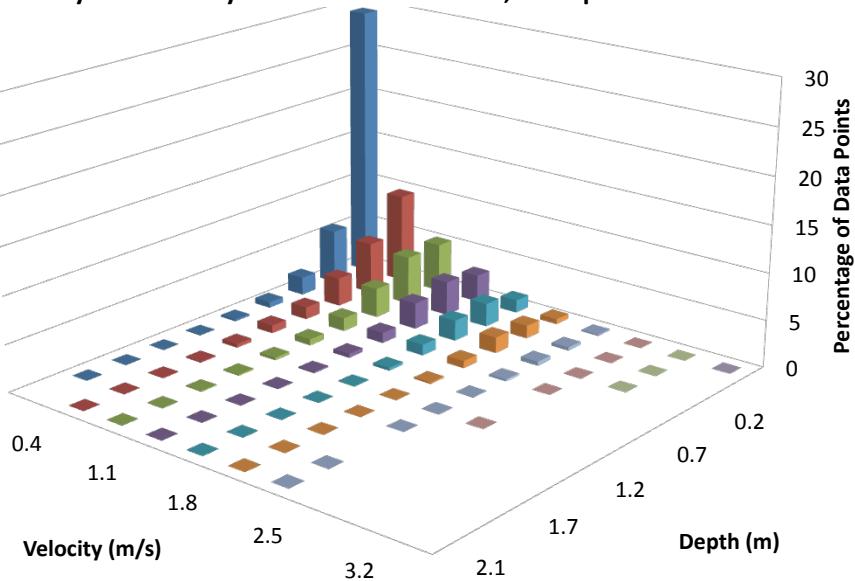


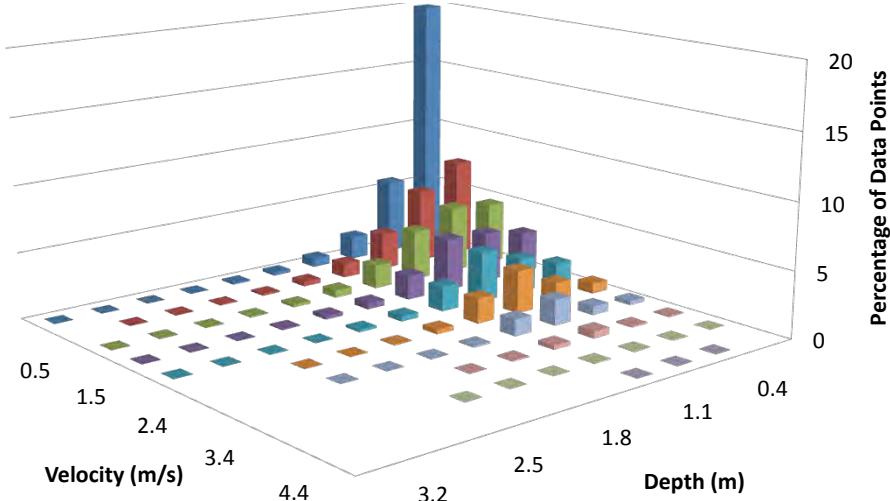
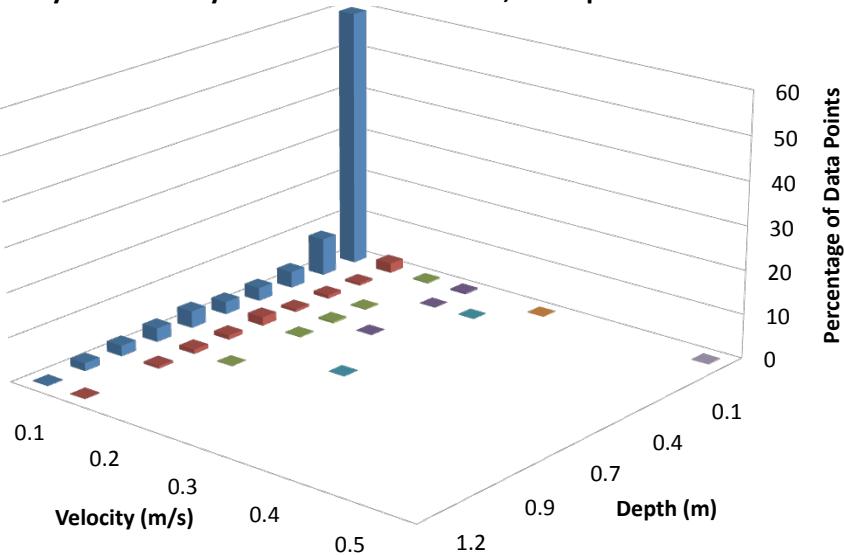
**Hydraulic Analysis: Dry Season 10 cfs, Floodplain Bedrock****Hydraulic Analysis: Dry Season 20 cfs, Floodplain Bedrock**

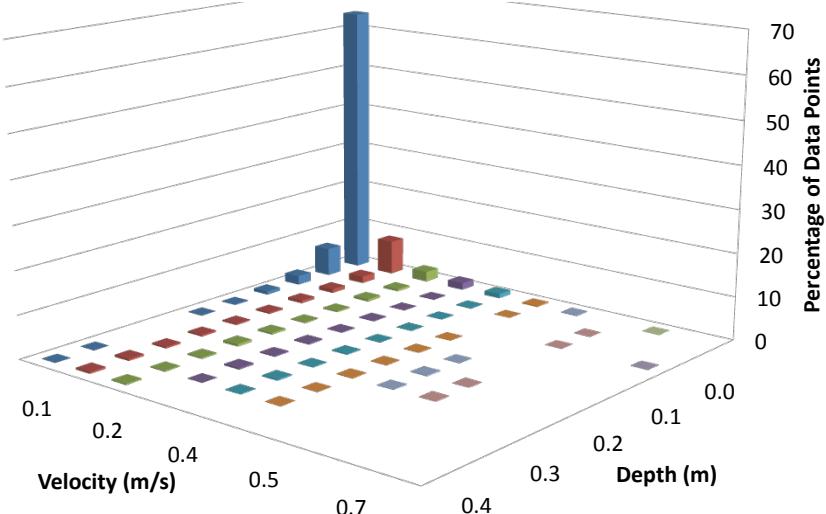
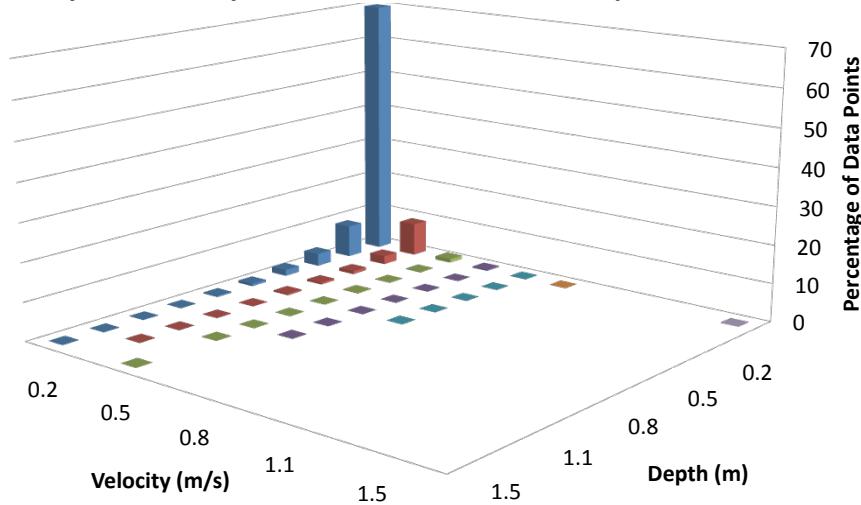
**Hydraulic Analysis: Dry Season 30 cfs, Floodplain Bedrock****Hydraulic Analysis: Dry Season 45 cfs, Floodplain Bedrock**

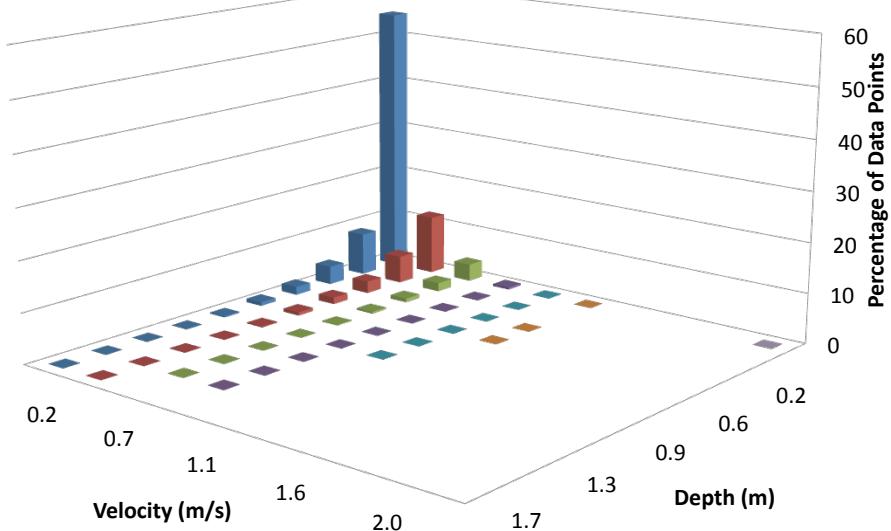
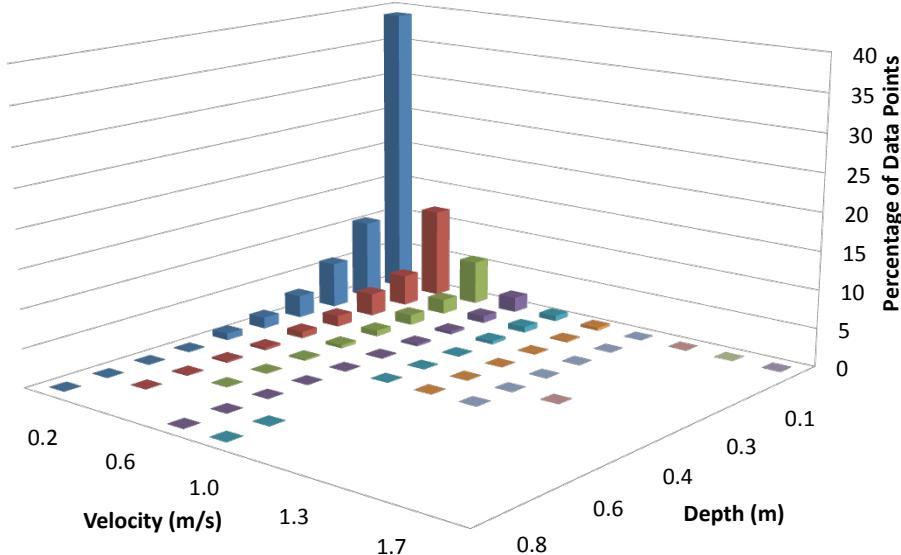
**Hydraulic Analysis: Wet Season 5 cfs, Floodplain Bedrock****Hydraulic Analysis: Wet Season 15 cfs, Floodplain Bedrock**

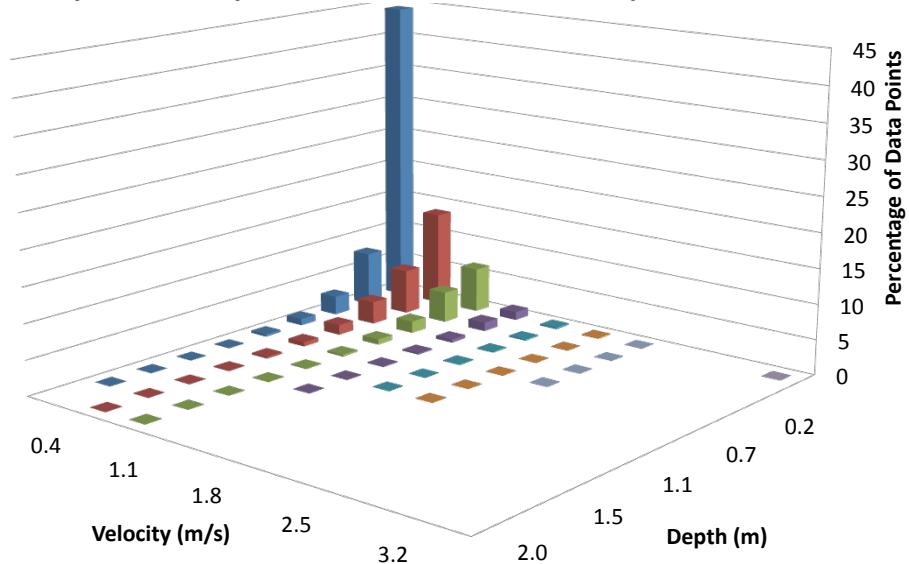
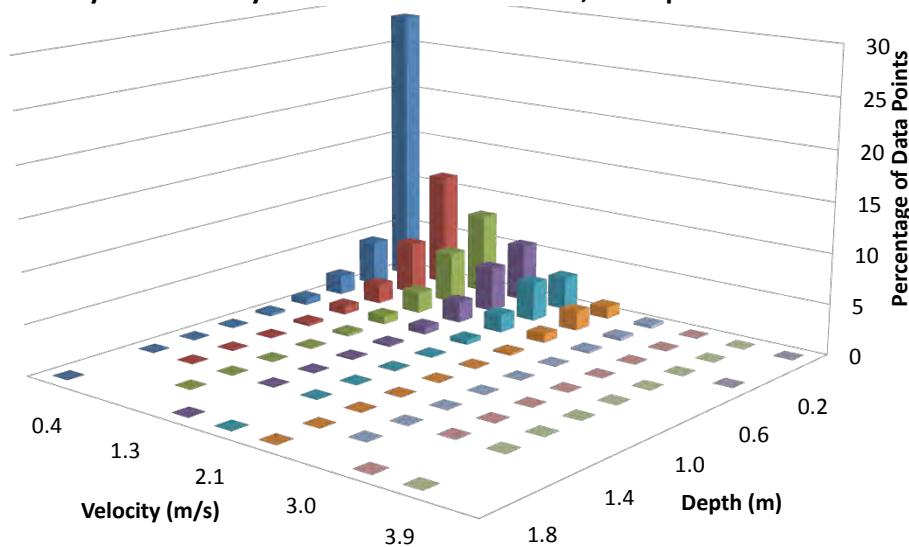
**Hydraulic Analysis: Wet Season 30 cfs, Floodplain Bedrock****Hydraulic Analysis: Wet Season 55 cfs, Floodplain Bedrock**

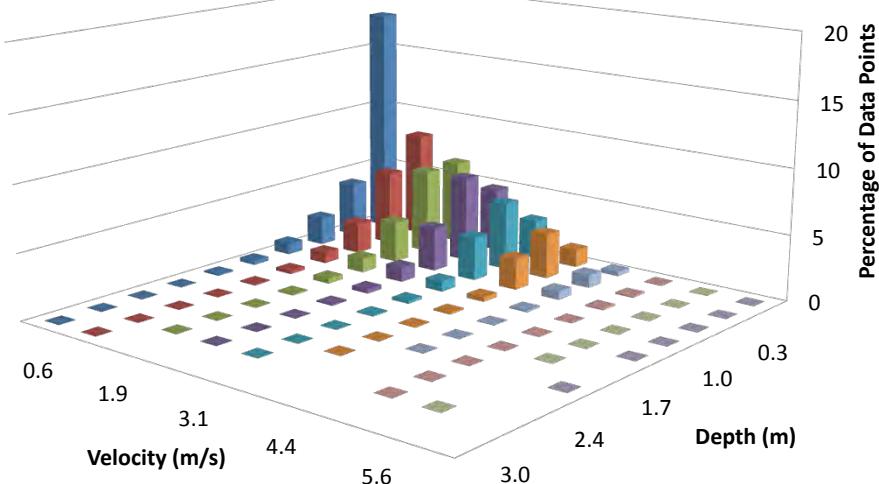
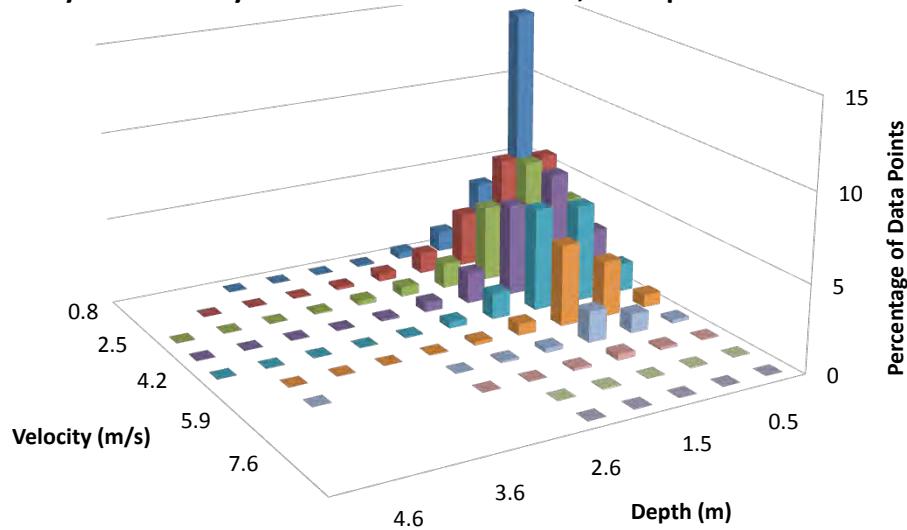
**Hydraulic Analysis: Wet Season 100 cfs, Floodplain Bedrock****Hydraulic Analysis: Wet Season 190 cfs, Floodplain Bedrock**

**Hydraulic Analysis: Wet Season 350 cfs, Floodplain Bedrock****Hydraulic Analysis: Snow Season 10 cfs, Floodplain Bedrock**

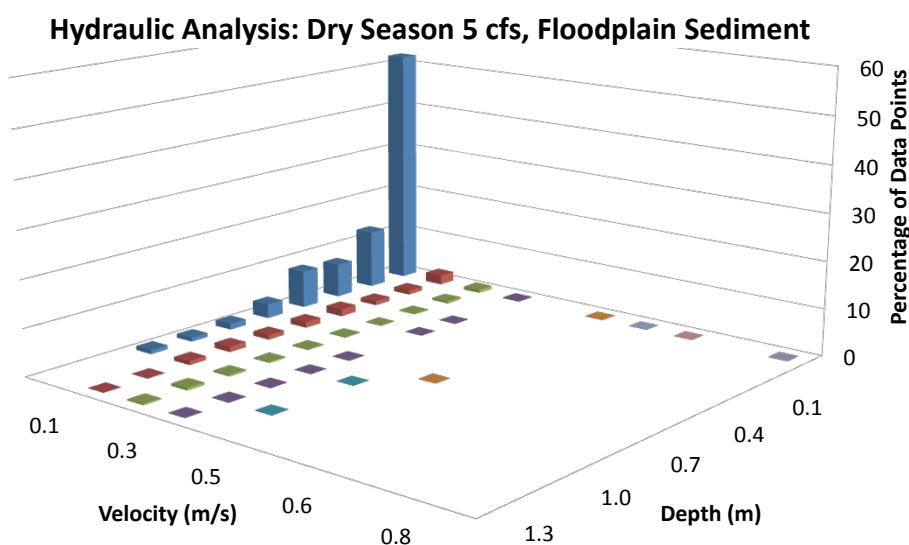
**Hydraulic Analysis: Snow Season 25 cfs, Floodplain Bedrock****Hydraulic Analysis: Snow Season 50 cfs, Floodplain Bedrock**

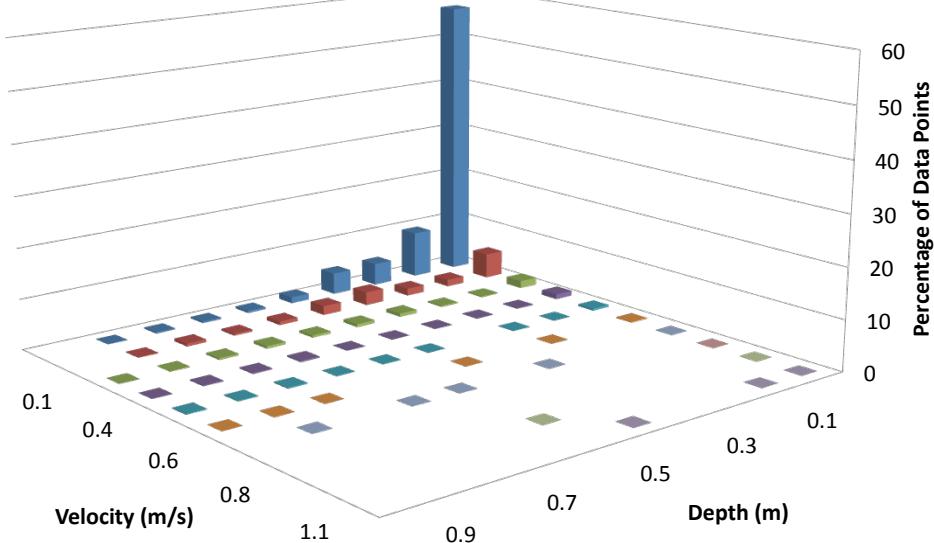
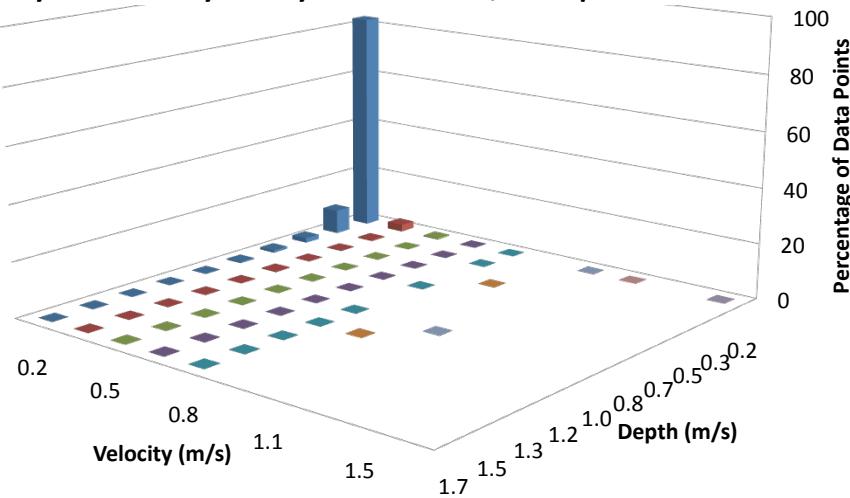
**Hydraulic Analysis: Snow Season 140 cfs, Floodplain Bedrock****Hydraulic Analysis: Snow Season 210 cfs, Floodplain Bedrock**

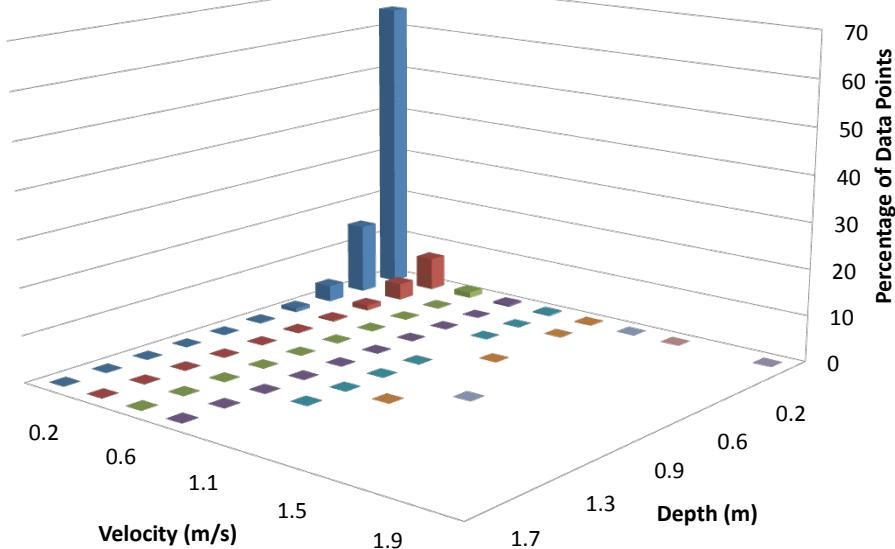
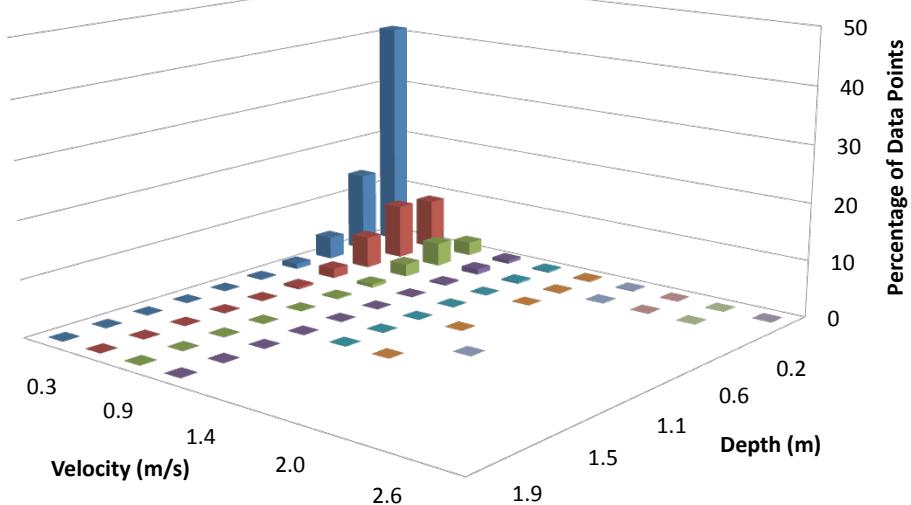
**Hydraulic Analysis: Snow Season 525 cfs, Floodplain Bedrock****Hydraulic Analysis: Snow Season 1103 cfs, Floodplain Bedrock**

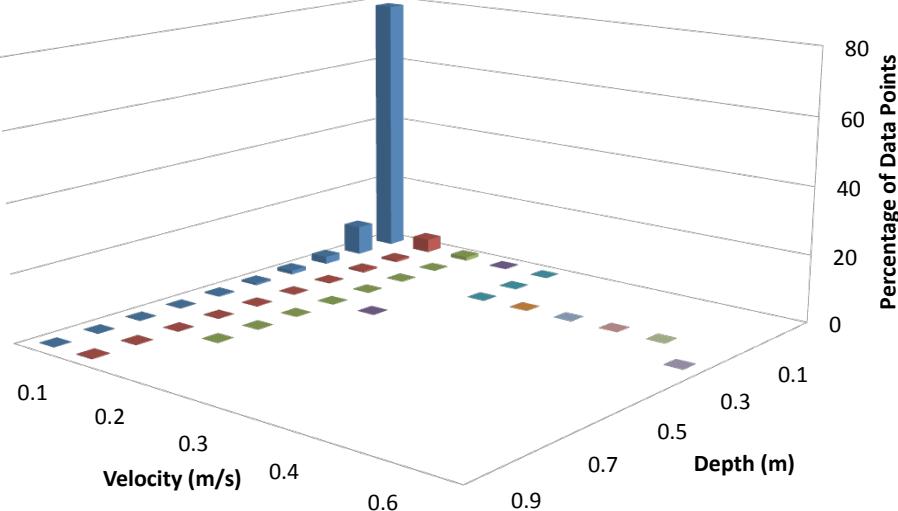
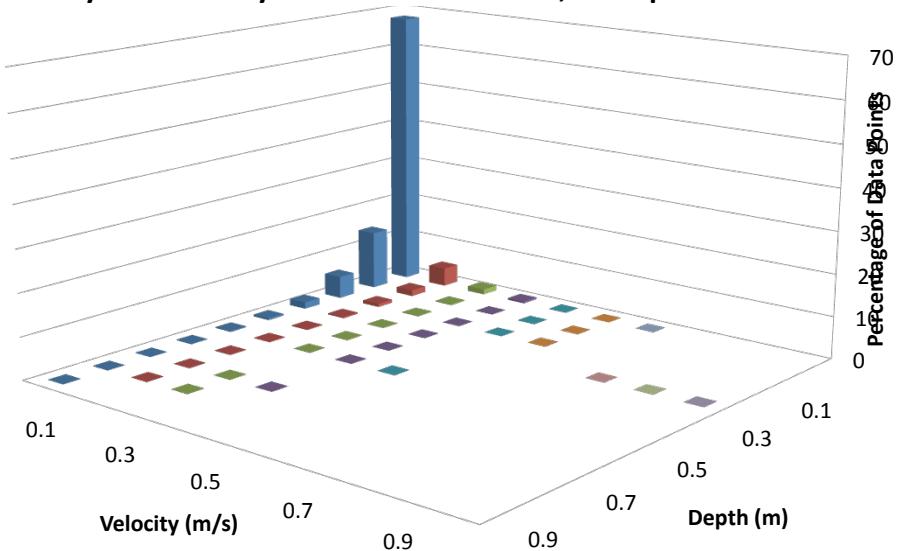
**Hydraulic Analysis: Snow Season 3000 cfs, Floodplain Bedrock****Hydraulic Analysis: Snow Season 6921 cfs, Floodplain Bedrock**

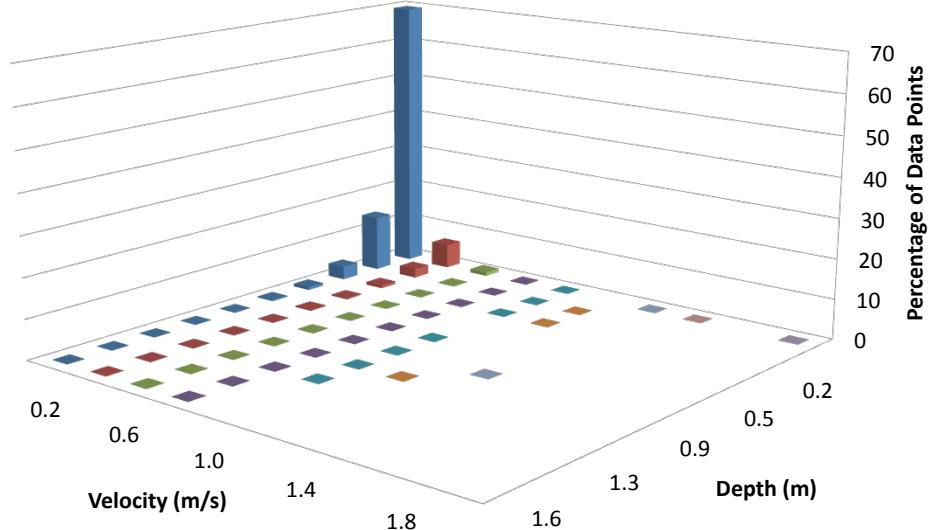
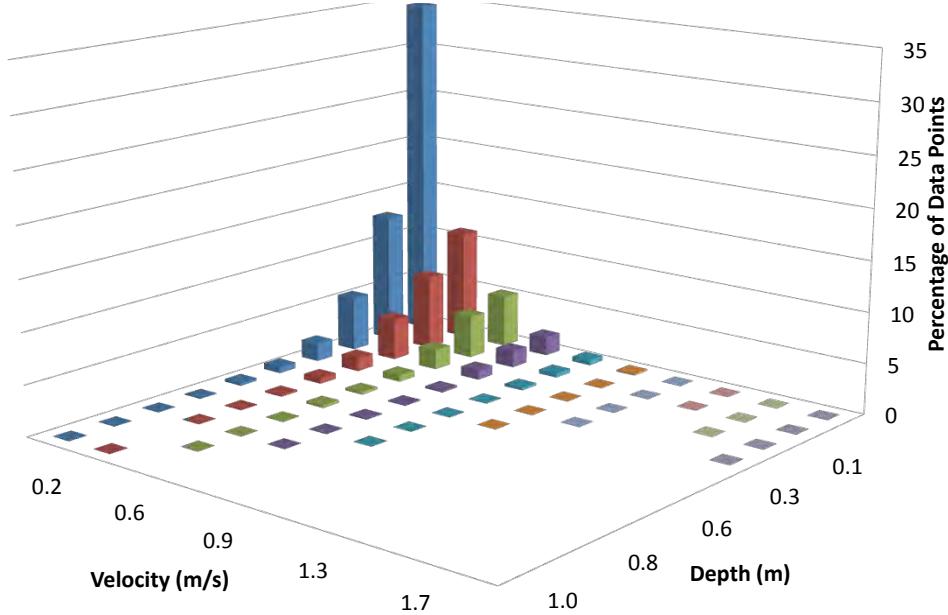
3D joint depth-velocity distributions  
across all flows and seasons,  
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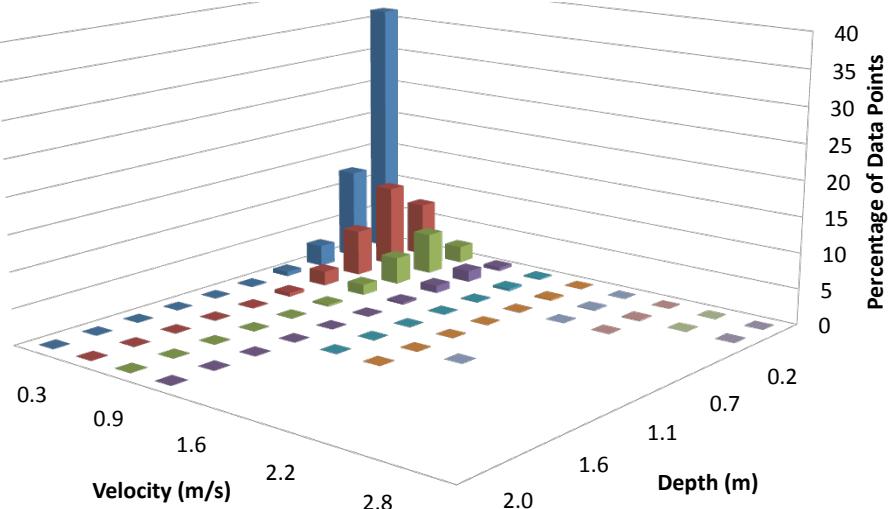
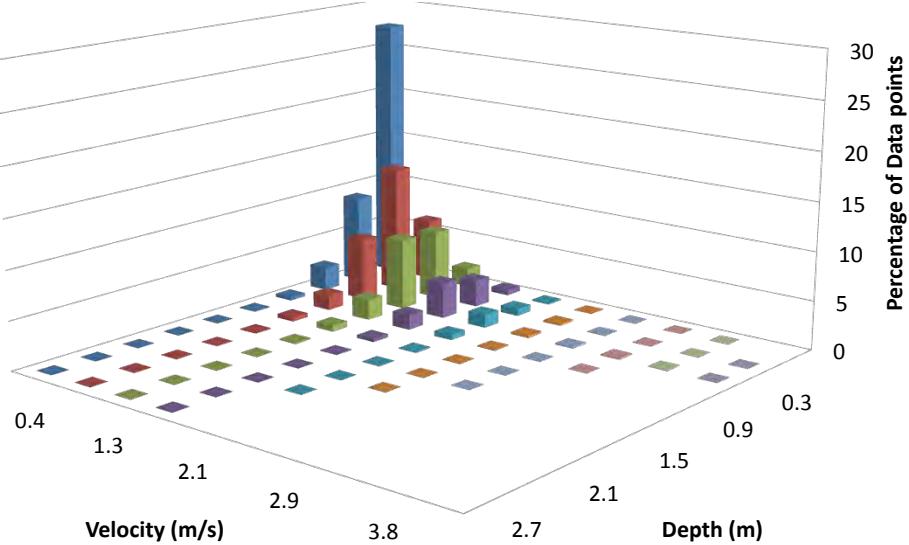


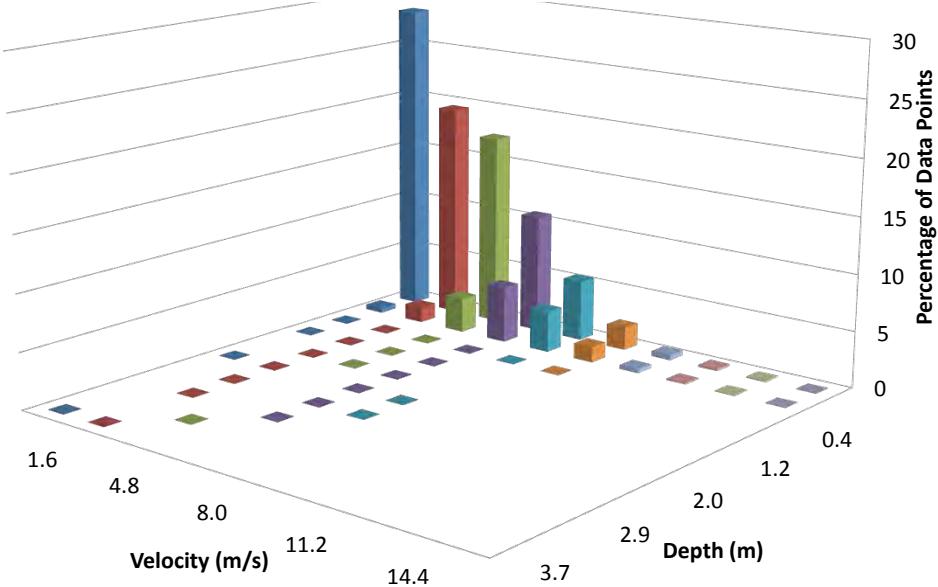
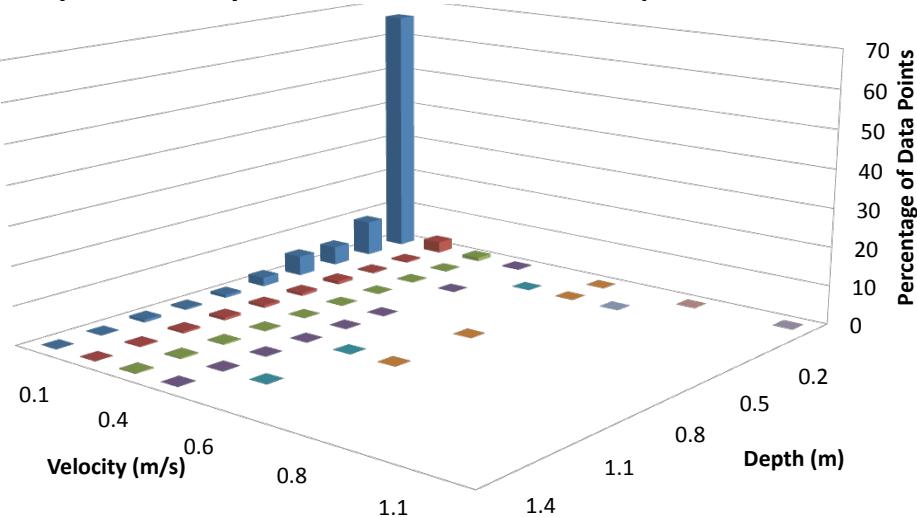
**Hydraulic Analysis: Dry Season 10 cfs, Floodplain Sediment****Hydraulic Analysis: Dry Season 20 cfs, Floodplain Sediment**

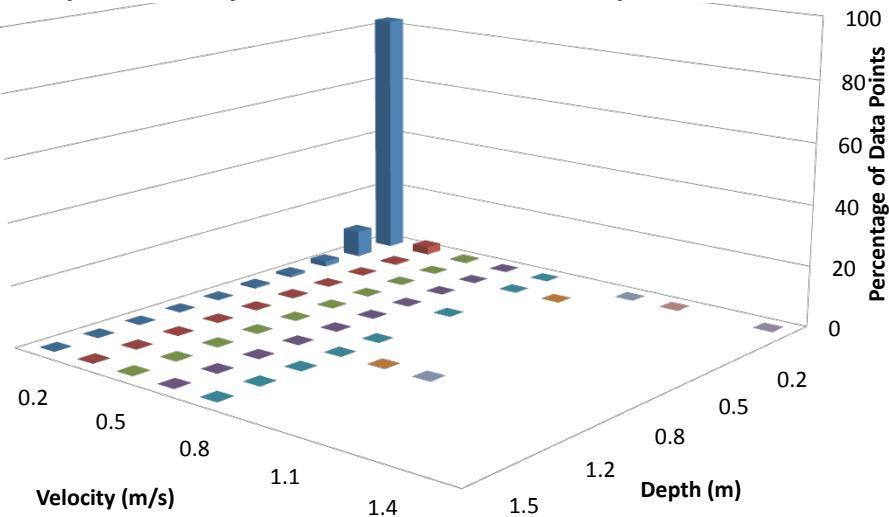
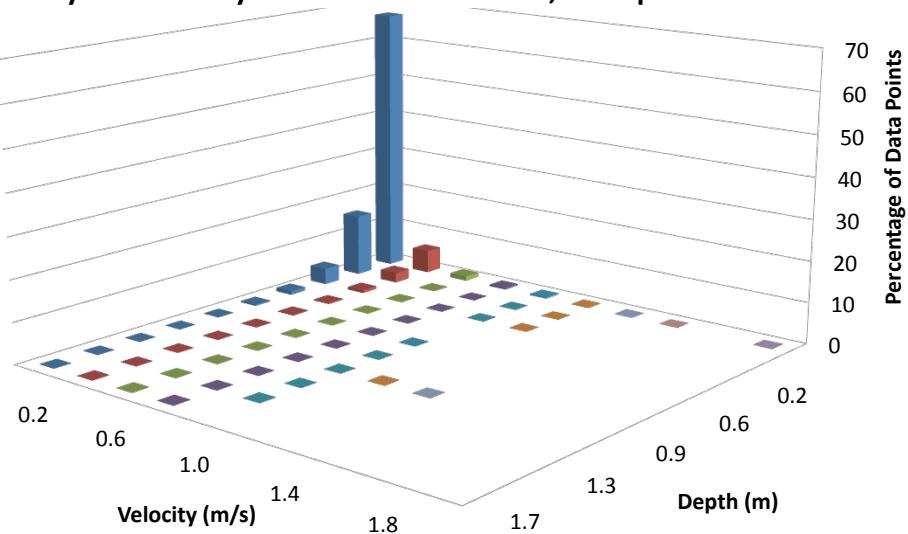
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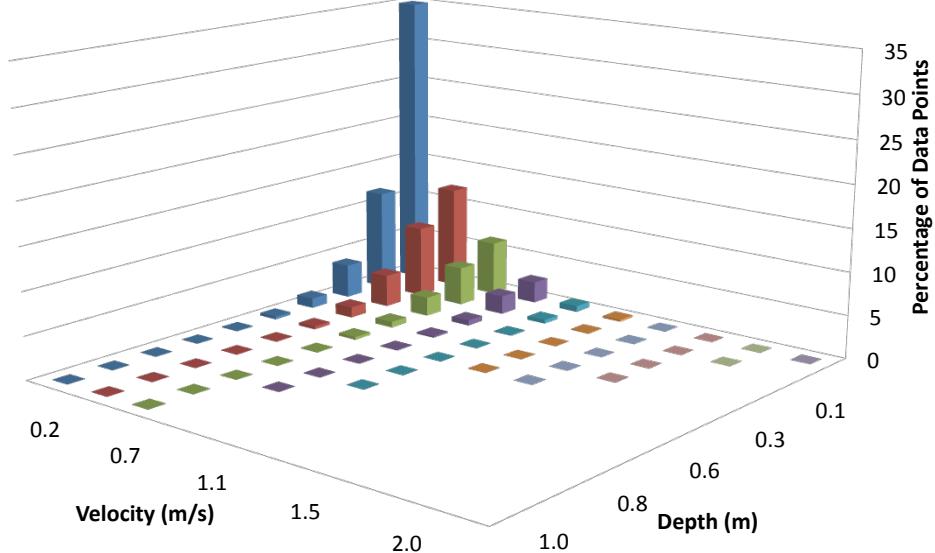
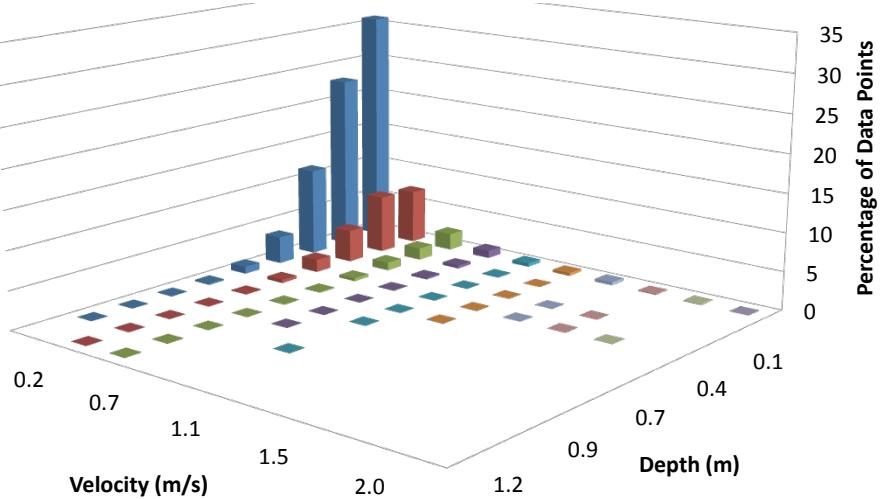
**Hydraulic Analysis: Wet Season 5 cfs, Floodplain Sediment****Hydraulic Analysis: Wet Season 15 cfs, Floodplain Sediment**

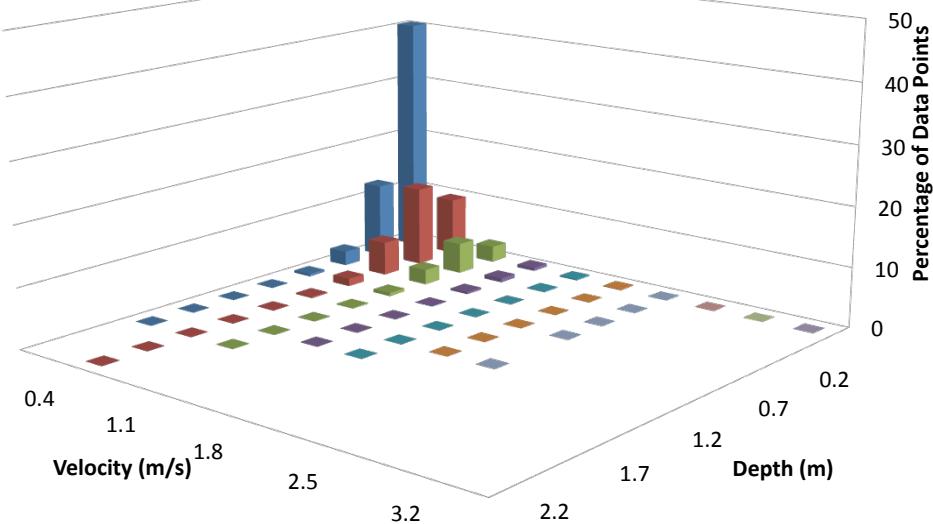
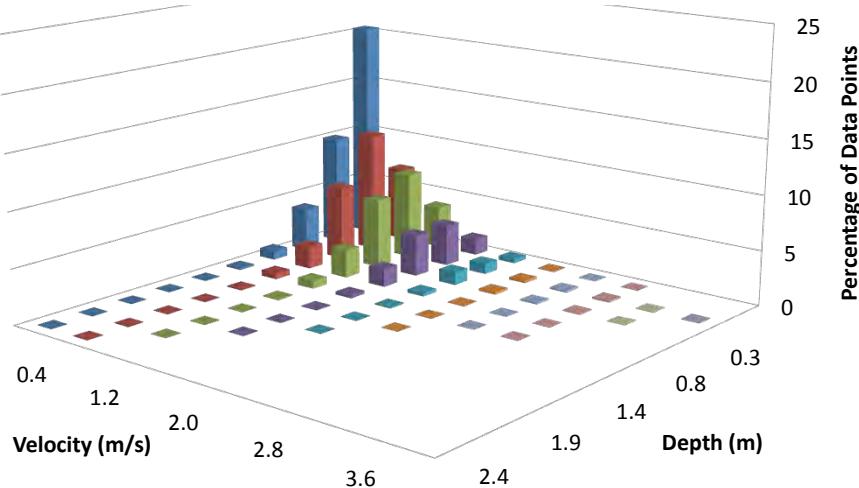
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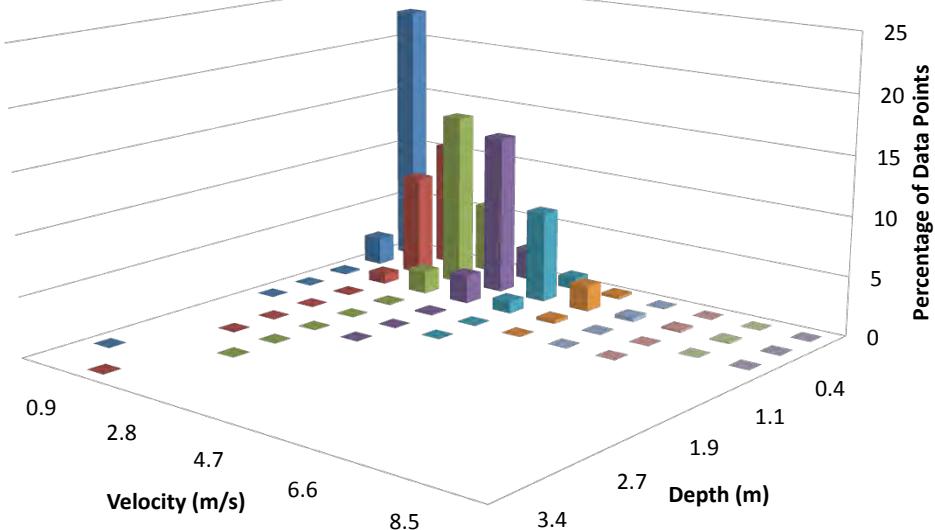
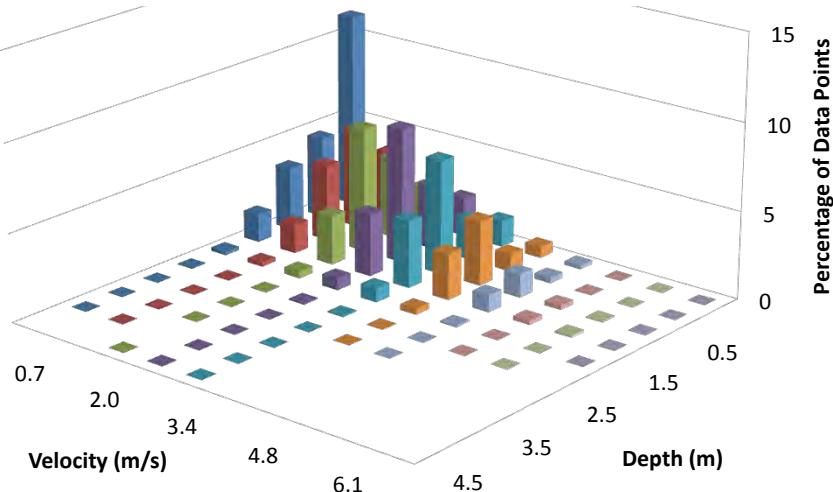
**Hydraulic Analysis: Wet Season 100 cfs, Floodplain Sediment****Hydraulic Analysis: Wet Season 190 cfs, Floodplain Sediment**

**Hydraulic Analysis: Wet Season 350 cfs, Floodplain Sediment****Hydraulic Analysis: Snow Season 10 cfs, Floodplain Sediment**

**Hydraulic Analysis: Snow Season 25 cfs, Floodplain Sediment****Hydraulic Analysis: Snow Season 50 cfs, Floodplain Sediment**

**Hydraulic Analysis: Snow Season 140 cfs, Floodplain Sediment****Hydraulic Analysis: Snow Season 210 cfs, Floodplain Sediment**

**Hydraulic Analysis: Snow Season 525 cfs, Floodplain Sediment****Hydraulic Analysis: Snow Season 1103 cfs, Floodplain Sediment**

**Hydraulic Analysis: Snow Season 3000 cfs, Floodplain Sediment****Hydraulic Analysis: Snow Season 6921 cfs, Floodplain Sediment**

**APPENDIX B:**  
**Data Table of % GHSI binned values and 3-D Graphical  
representation of distribution by species lifestage,  
SYLC flow, and season**

### SACRAMENTO SUCKER

Dry Season	ADULT					JUVENILE				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	16.0	2.0	2.0	2.0	77.9	31.9	3.7	3.5	3.6	57.2
10	16.5	2.1	2.1	2.1	77.3	30.9	3.6	3.5	3.6	58.3
20	17.1	2.1	2.1	2.2	76.5	23.8	3.4	3.3	3.4	66.2
30	13.5	2.0	2.1	2.1	80.3	16.8	2.8	2.8	2.9	74.7
45	8.5	1.6	1.6	1.7	86.6	10.6	2.1	2.1	2.2	83.0

### RAINBOW TROUT

Dry Season	ADULT					JUVENILE				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	8.6	15.2	21.6	24.0	30.6	17.2	3.1	3.1	3.3	73.3
10	17.3	15.9	21.7	18.2	26.9	13.7	2.8	2.8	3.3	77.5
20	26.5	19.8	19.5	13.7	20.6	8.0	2.0	2.0	2.3	85.6
30	25.8	24.1	18.9	12.3	19.0	5.8	1.5	1.5	1.8	89.3
45	19.3	24.7	24.6	12.7	18.7	3.4	1.0	1.1	1.2	93.3

### PIKEMINNOW/HARDHEAD

Dry Season	ADULT					JUVENILE				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	33.2	8.8	8.9	11.4	37.7	50.0	6.3	6.8	5.4	31.4
10	34.2	9.6	10.4	12.3	33.6	50.4	7.9	7.6	5.7	28.4
20	35.7	11.3	13.5	13.3	26.1	46.9	12.1	9.8	6.5	24.7
30	33.8	13.1	15.9	13.2	24.0	36.1	17.5	12.1	7.2	27.1
45	26.4	16.0	19.2	13.4	25.0	22.4	16.0	17.4	10.0	34.2

Percent Distribution of 2D Model results

### SACRAMENTO SUCKER

Dry Season	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

### RAINBOW TROUT

	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	32.3	16.3	24.0	8.2	19.2	N/A	N/A	N/A	N/A	N/A
10	33.4	16.7	24.6	8.1	17.2					
20	28.0	18.9	29.4	8.6	15.0					
30	20.6	17.5	32.5	13.7	15.7					
45	13.3	12.7	29.6	25.9	18.6					

### PIKEMINNOW/HARDHEAD

	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

Percent Distribution of 2D Model results

### SACRAMENTO SUCKER

Wet Season	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
Flow (cfs)	5	17.1	2.1	2.1	2.1	76.6	N/A	N/A	N/A	N/A
	15	17.0	2.1	2.1	2.2	76.6				
	30	14.5	2.1	2.1	2.2	79.2				
	55	10.4	1.8	1.8	1.9	84.1				
	100	6.4	1.4	1.4	1.5	89.3				
	190	3.3	0.9	0.9	1.0	93.9				
	350	2.0	0.6	0.6	0.7	96.2				

### RAINBOW TROUT

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	21.7	17.2	21.0	16.1	24.1	32.2	17.6	26.4	8.0	15.9
15	26.4	19.9	19.4	13.7	20.6	27.8	18.8	29.6	8.8	15.0
30	26.6	23.3	18.5	12.7	18.9	21.9	18.1	32.6	12.2	15.2
55	22.3	26.2	21.0	12.1	18.4	16.0	14.9	31.6	20.6	16.8
100	15.3	22.2	28.7	14.0	19.8	10.2	10.4	25.1	33.0	21.4
190	8.1	12.4	26.8	22.9	29.8	5.9	6.3	14.4	34.7	38.8
350	4.5	6.9	13.0	17.2	58.3	3.2	3.6	8.7	19.0	65.5

### PIKEMINNOW/HARDHEAD

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	35.1	10.3	11.6	12.7	30.4	49.9	9.3	8.4	6.1	26.4
15	35.7	11.3	13.5	13.3	26.1	46.7	12.2	9.8	6.5	24.8
30	34.6	12.6	15.6	13.2	24.0	38.7	16.5	11.5	7.1	26.2
55	30.2	15.1	17.5	13.3	23.9	27.6	18.2	15.5	8.3	30.3
100	21.0	16.3	21.8	13.9	27.1	17.0	13.4	16.0	12.2	41.4
190	10.1	10.7	20.5	16.4	42.4	9.5	7.5	9.4	10.9	62.7
350	5.6	4.9	10.3	11.2	67.9	5.3	4.2	5.1	6.5	78.9

Percent Distribution of 2D Model results

### SACRAMENTO SUCKER

Wet Season	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15										
30										
55										
100										
190										
350										

### RAINBOW TROUT

	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	39.6	9.2	7.8	8.2	35.2
15						41.5	8.8	6.8	7.2	35.7
30						39.1	9.1	6.9	7.5	37.5
55						34.3	9.3	7.2	7.6	41.6
100						25.1	9.2	7.6	8.1	50.0
190						15.7	5.7	5.4	7.0	66.2
350						9.0	3.8	3.6	4.6	79.0

### PIKEMINNOW/HARDHEAD

	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15										
30										
55										
100										
190										
350										

Percent Distribution of 2D Model results

### SACRAMENTO SUCKER

Snowmelt

Season Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	16.7	2.1	2.1	2.1	77.0	30.5	3.6	3.5	3.6	58.8
25	17.2	2.1	2.1	2.2	76.4	24.3	3.4	3.3	3.5	65.5
50	14.3	2.0	2.1	2.2	79.4	17.4	2.9	2.8	2.9	73.9
140	10.1	1.8	1.8	1.9	84.4	12.3	2.3	2.3	2.4	80.7
210	13.0	1.9	2.0	2.1	81.0	14.8	2.7	2.6	2.8	77.1
525	6.5	1.4	1.5	1.5	89.1	8.1	1.8	1.8	1.9	86.4
1103	3.2	0.9	0.9	1.0	94.0	4.1	1.2	1.2	1.2	92.4
3000	1.6	0.5	0.6	0.6	96.8	2.0	0.7	0.7	0.7	95.9
6921	0.9	0.3	0.4	0.4	97.9	1.3	0.5	0.5	0.5	97.2

### RAINBOW TROUT

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	18.4	16.0	21.6	17.7	26.2	33.2	16.8	25.0	8.0	16.9
25	26.0	19.2	19.5	14.0	21.1	28.6	18.9	28.8	8.5	15.3
50	26.5	23.3	18.3	12.7	19.2	21.2	18.0	32.8	12.4	15.7
140	22.0	26.6	21.0	12.0	18.4	15.3	14.3	32.1	21.5	16.9
210	25.5	24.5	19.0	12.2	18.8	18.0	16.6	34.1	15.1	16.2
525	15.6	23.0	28.1	13.9	19.4	10.3	10.4	25.4	32.7	21.2
1103	8.2	13.4	28.4	21.7	28.3	5.4	6.2	15.0	36.6	36.8
3000	3.4	5.6	11.6	16.9	62.4	2.5	2.8	6.9	17.9	69.9
6921	2.2	3.6	6.3	9.0	78.9	1.7	1.8	4.8	10.0	81.7

### PIKEMINNOW/HARDHEAD

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	34.4	9.7	10.7	12.4	32.8	50.3	8.2	7.8	5.8	27.9
25	35.6	11.1	13.3	13.3	26.7	47.3	11.7	9.6	6.5	25.0
50	34.4	12.6	15.7	13.1	24.2	37.8	16.8	11.6	7.1	26.7
140	29.8	15.2	17.7	13.3	24.0	26.4	18.3	15.7	8.6	31.0
210	32.7	13.4	16.7	13.2	24.0	33.2	17.3	12.9	7.8	28.7
525	22.5	15.3	20.9	14.6	26.7	17.4	14.2	16.9	11.2	40.3
1103	10.6	11.6	22.0	15.7	40.1	8.9	8.0	10.0	12.0	61.1
3000	4.5	4.0	8.8	10.7	71.9	4.2	3.2	4.2	5.9	82.4
6921	2.9	2.3	4.7	6.9	83.2	2.7	2.1	2.8	4.0	88.4

Percent Distribution of 2D Model results

APB-6

## SACRAMENTO SUCKER

Snowmelt

Season	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
Flow (cfs)										
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										

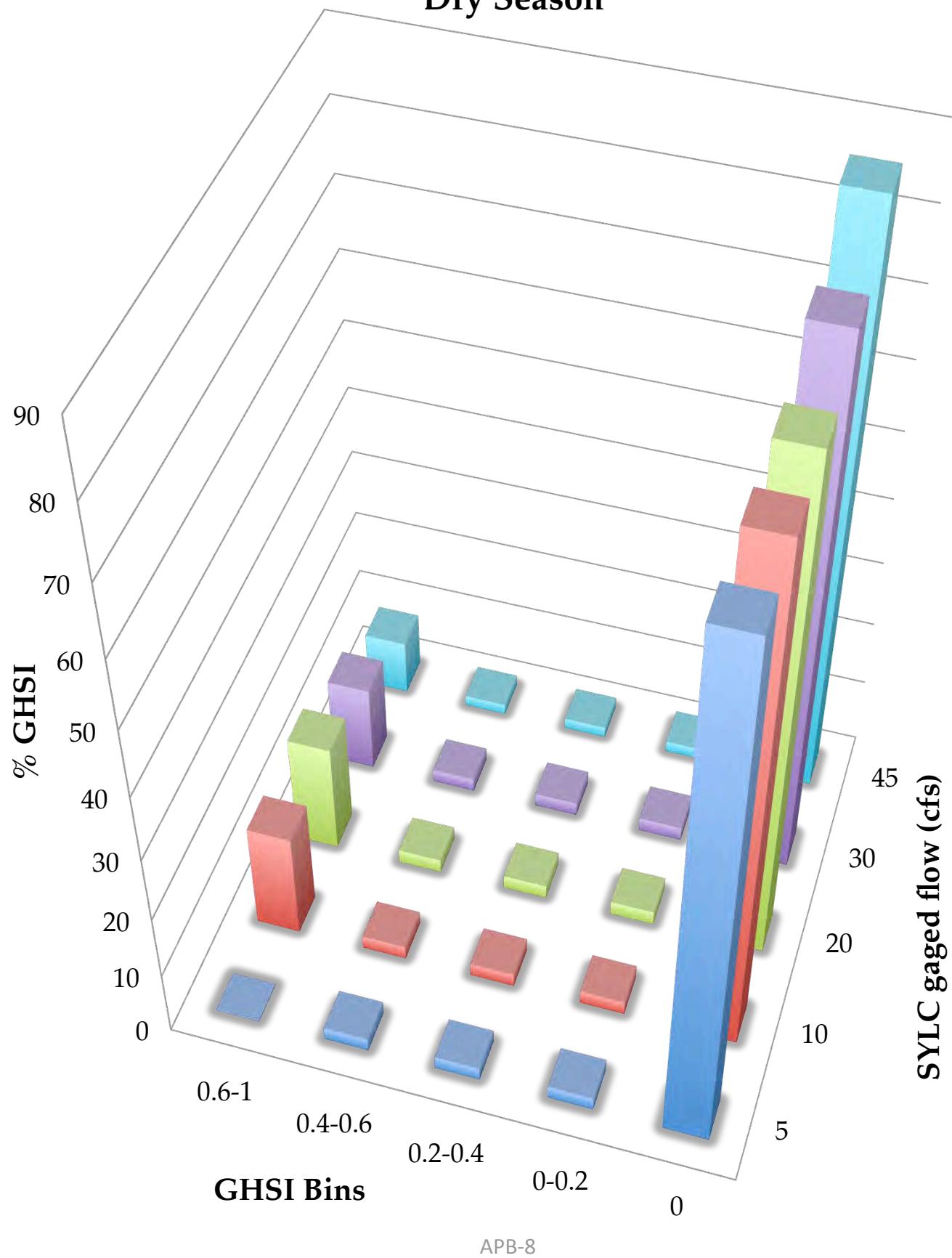
## RAINBOW TROUT

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	13.1	2.7	2.7	3.2	78.2	37.2	9.6	8.5	9.3	35.4
25	8.3	2.0	2.0	2.4	85.2	41.7	8.7	6.8	7.3	35.5
50	5.9	1.6	1.6	1.8	89.1	38.5	9.1	7.1	7.4	37.9
140	4.1	1.2	1.2	1.4	92.1	33.3	9.7	7.4	7.6	41.9
210	5.1	1.4	1.4	1.6	90.5	35.8	10.0	7.5	7.7	38.9
525	2.4	0.8	0.8	1.0	94.9	25.5	8.6	7.4	8.3	50.1
1103	1.1	0.5	0.5	0.5	97.4	15.8	5.7	5.5	7.0	65.9
3000	0.6	0.3	0.3	0.3	98.5	6.7	3.2	3.2	4.4	82.4
6921	0.4	0.2	0.2	0.2	98.9	4.9	2.3	2.3	3.0	87.5

## PIKEMINNOW/HARDHEAD

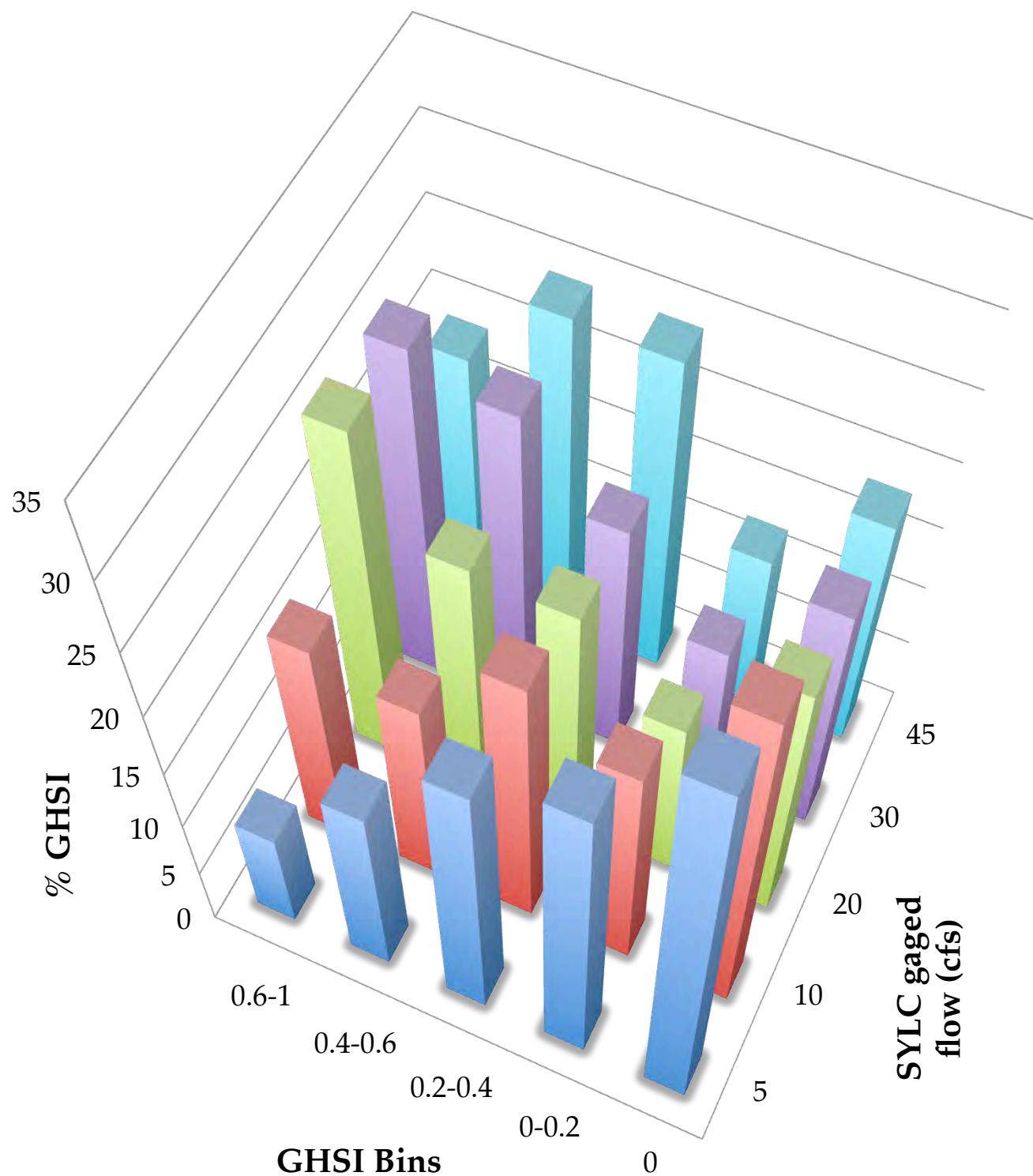
Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										

## Adult Sacramento Sucker Dry Season

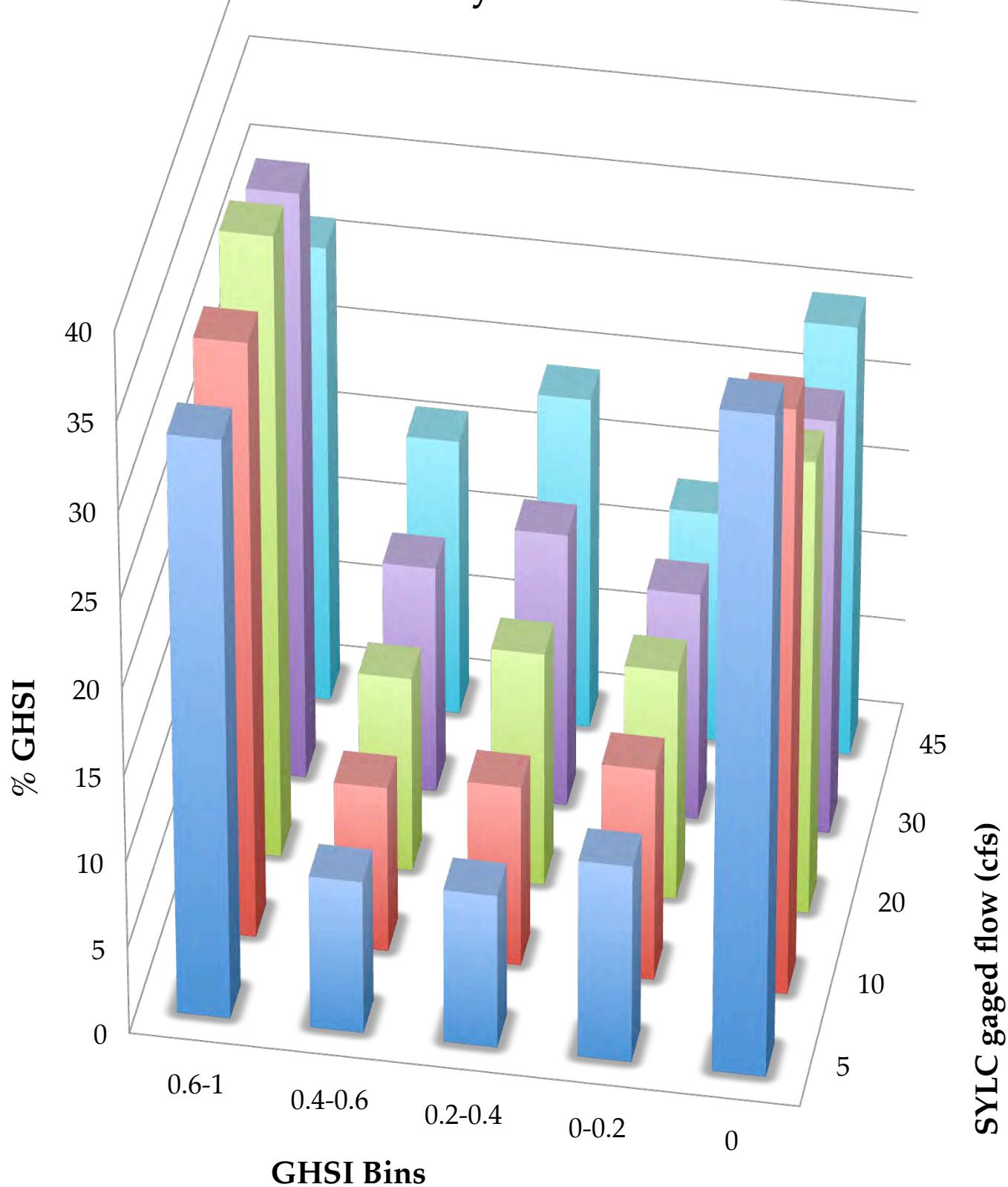


APB-8

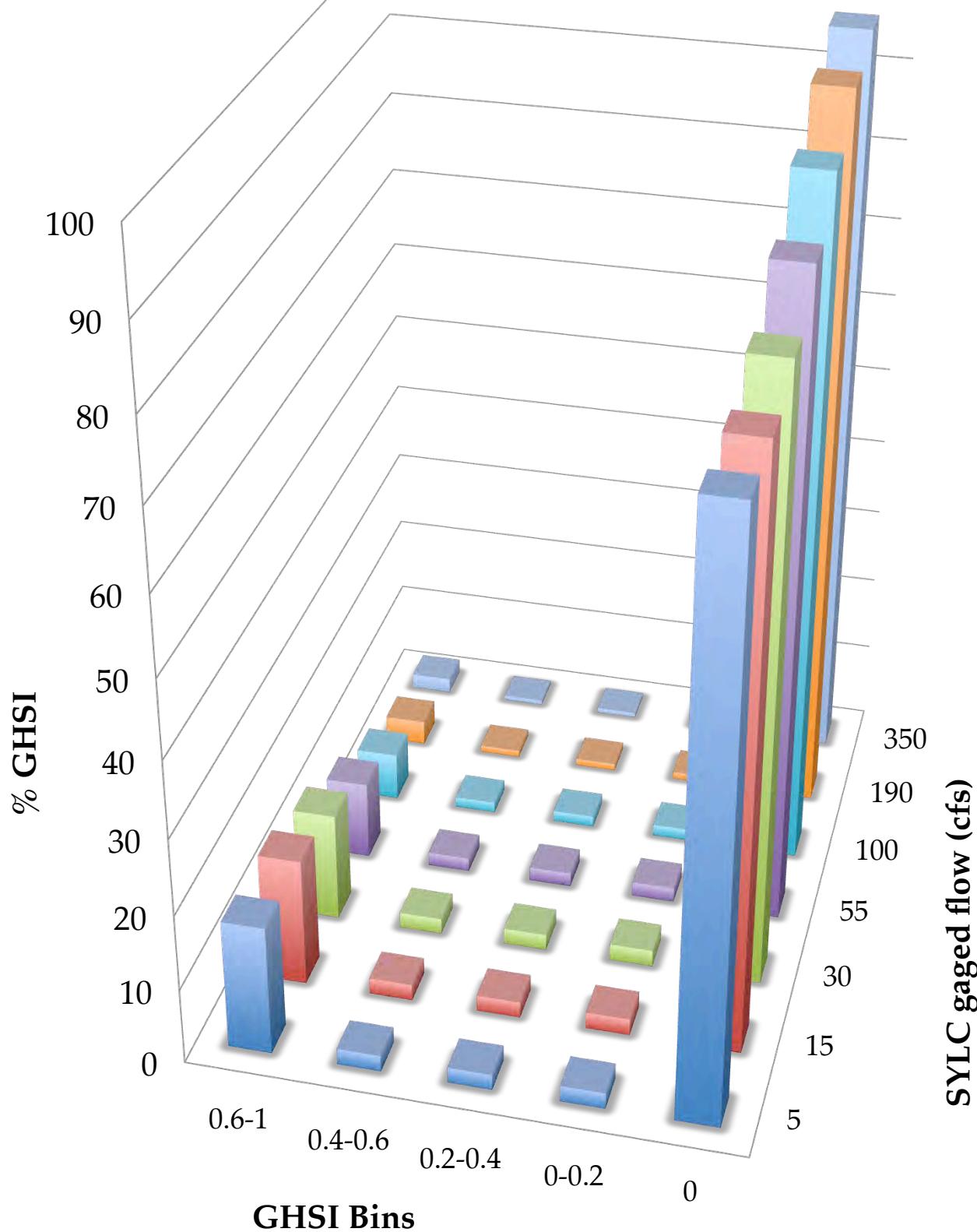
## Adult Rainbow Trout Dry Season



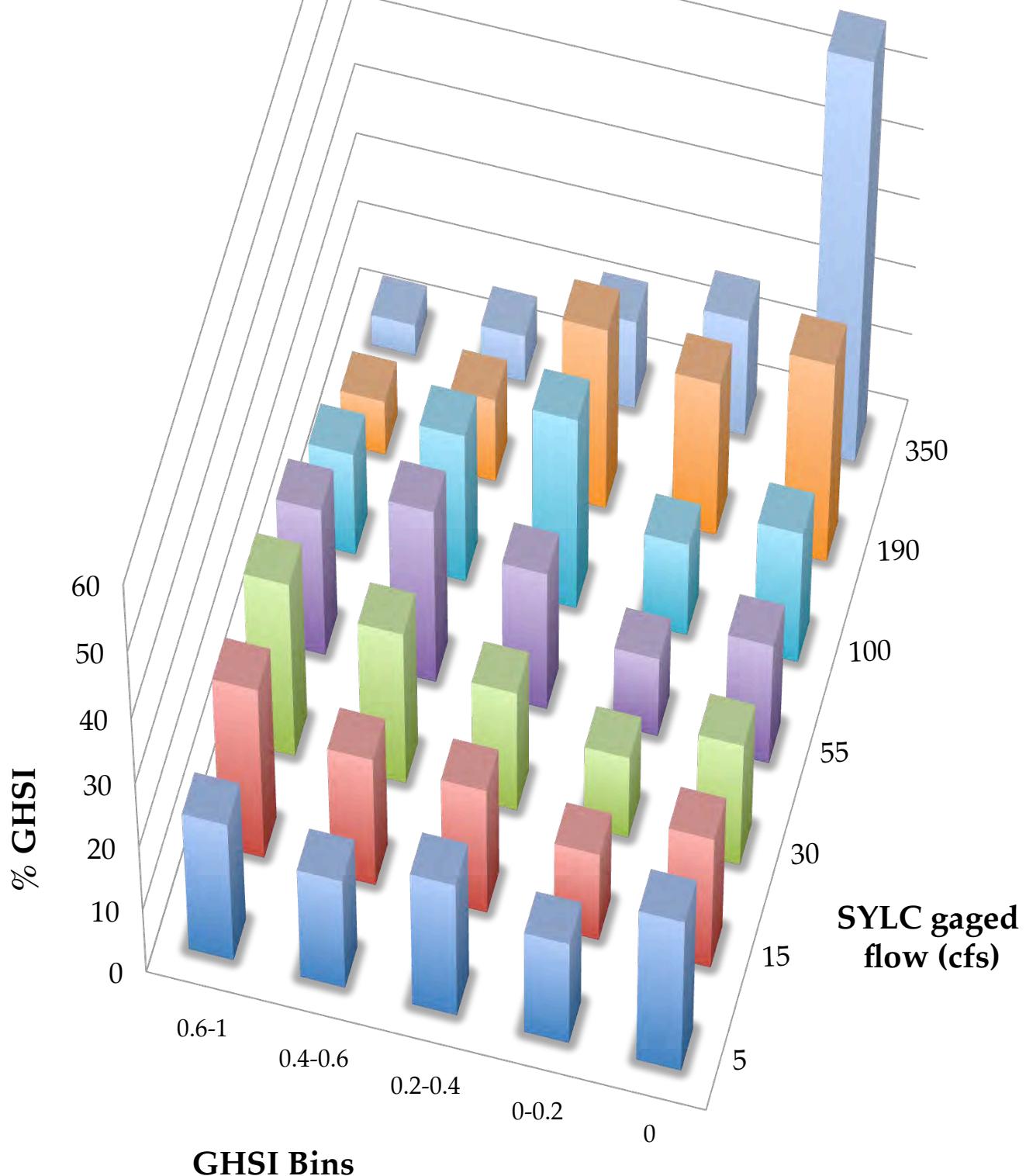
## Adult Pikeminnow/Hardhead Dry Season



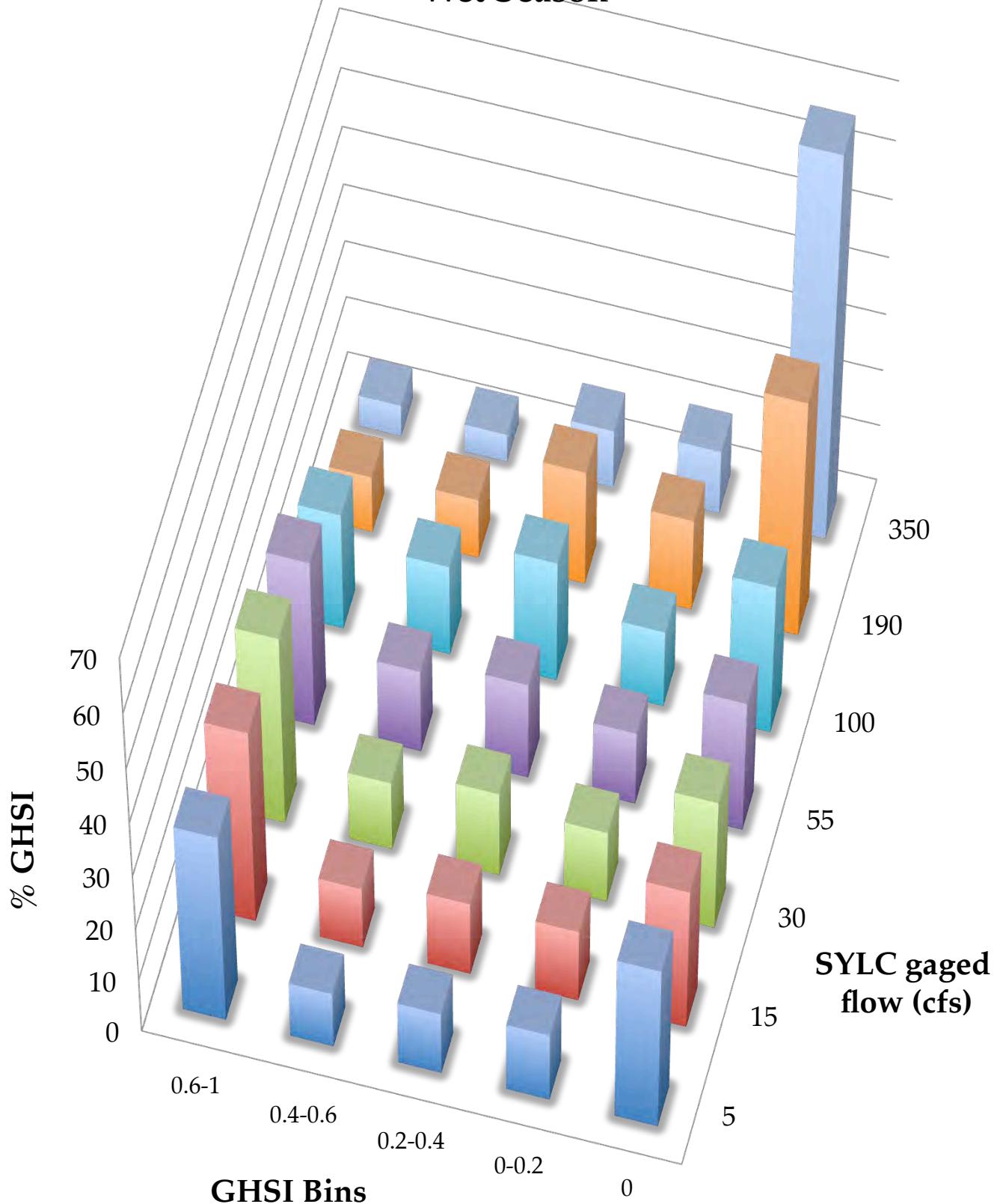
## Adult Sacramento Sucker Wet Season



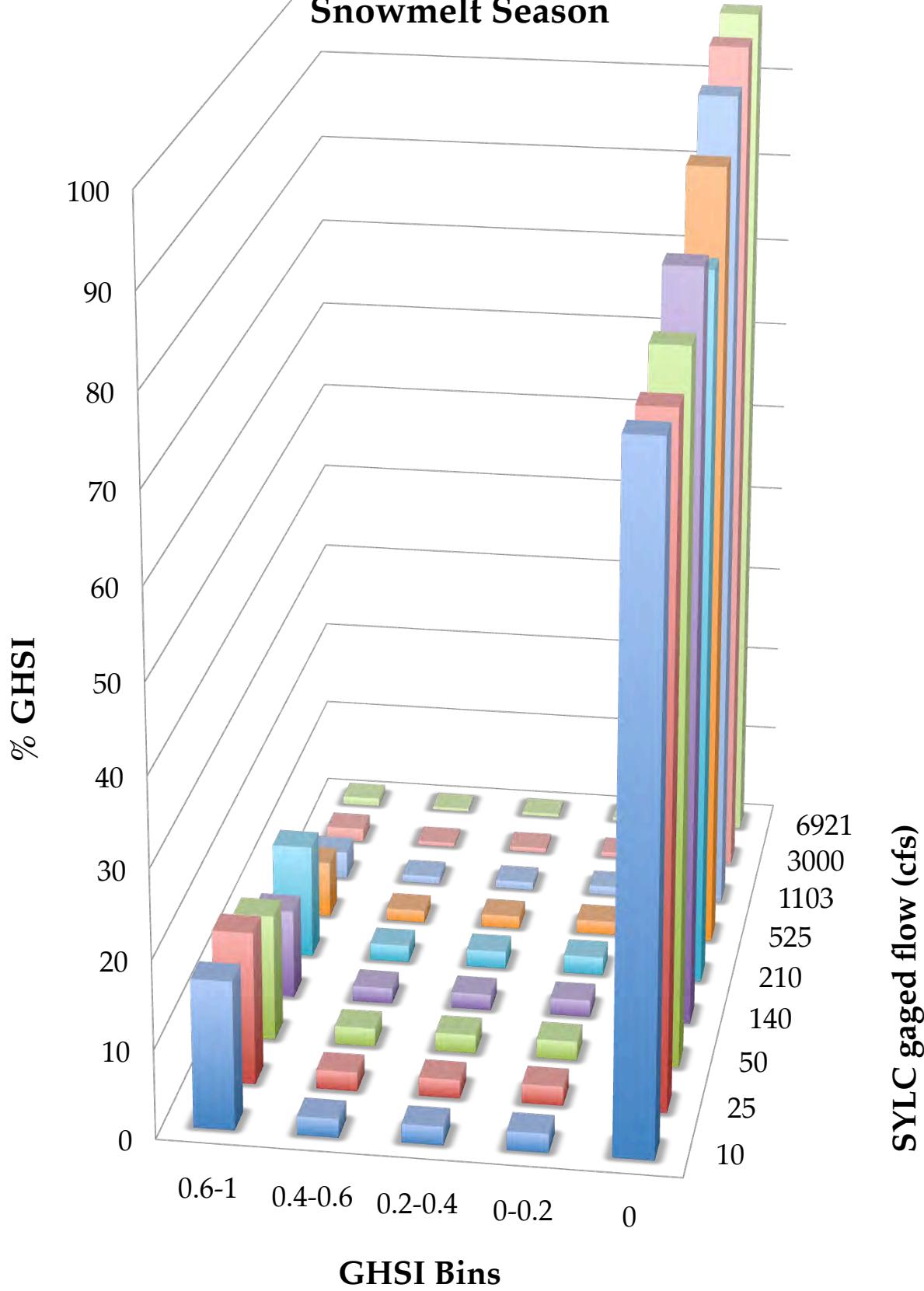
## **Adult Rainbow Trout Wet Season**



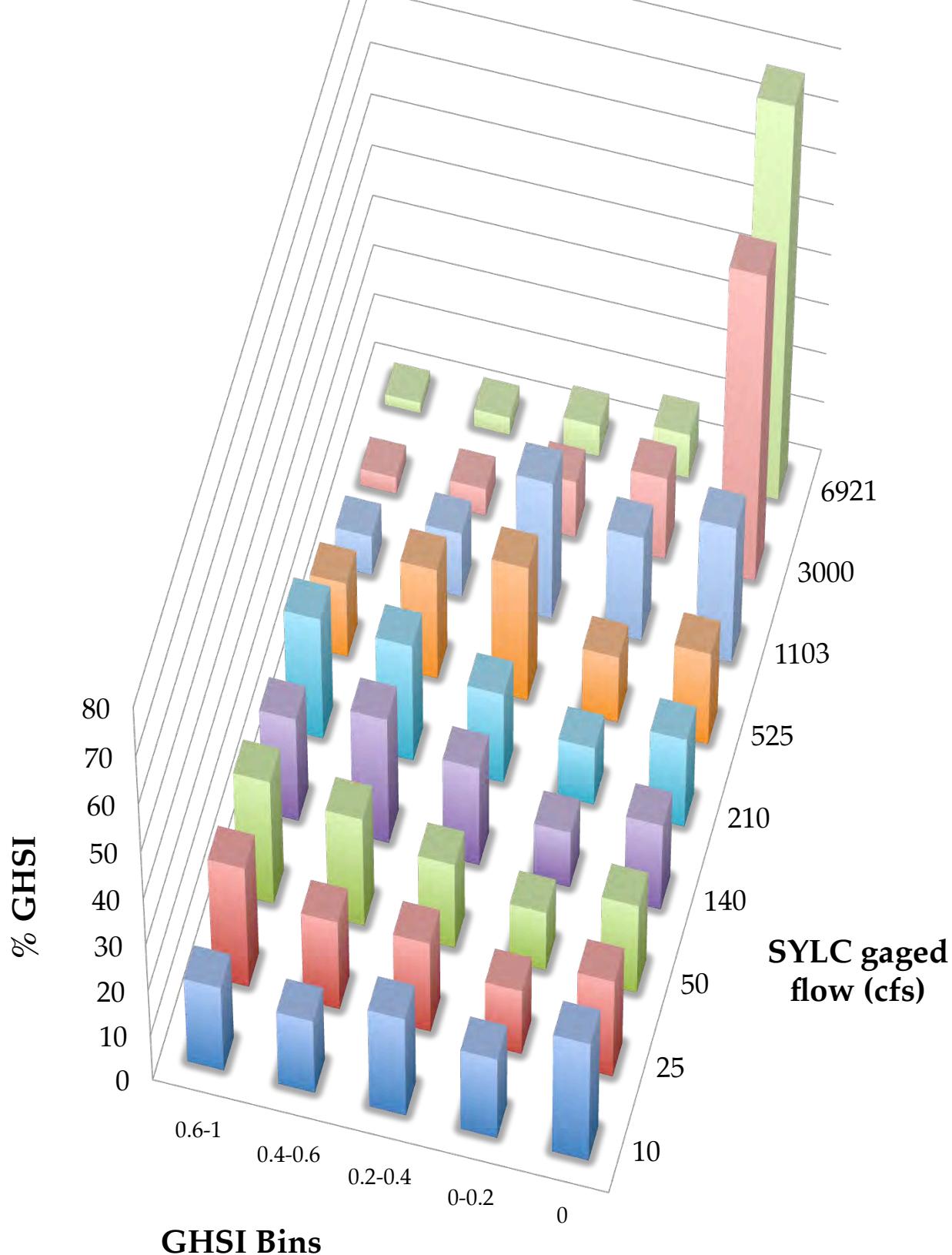
## Adult Pikeminnow/Hardhead Wet Season



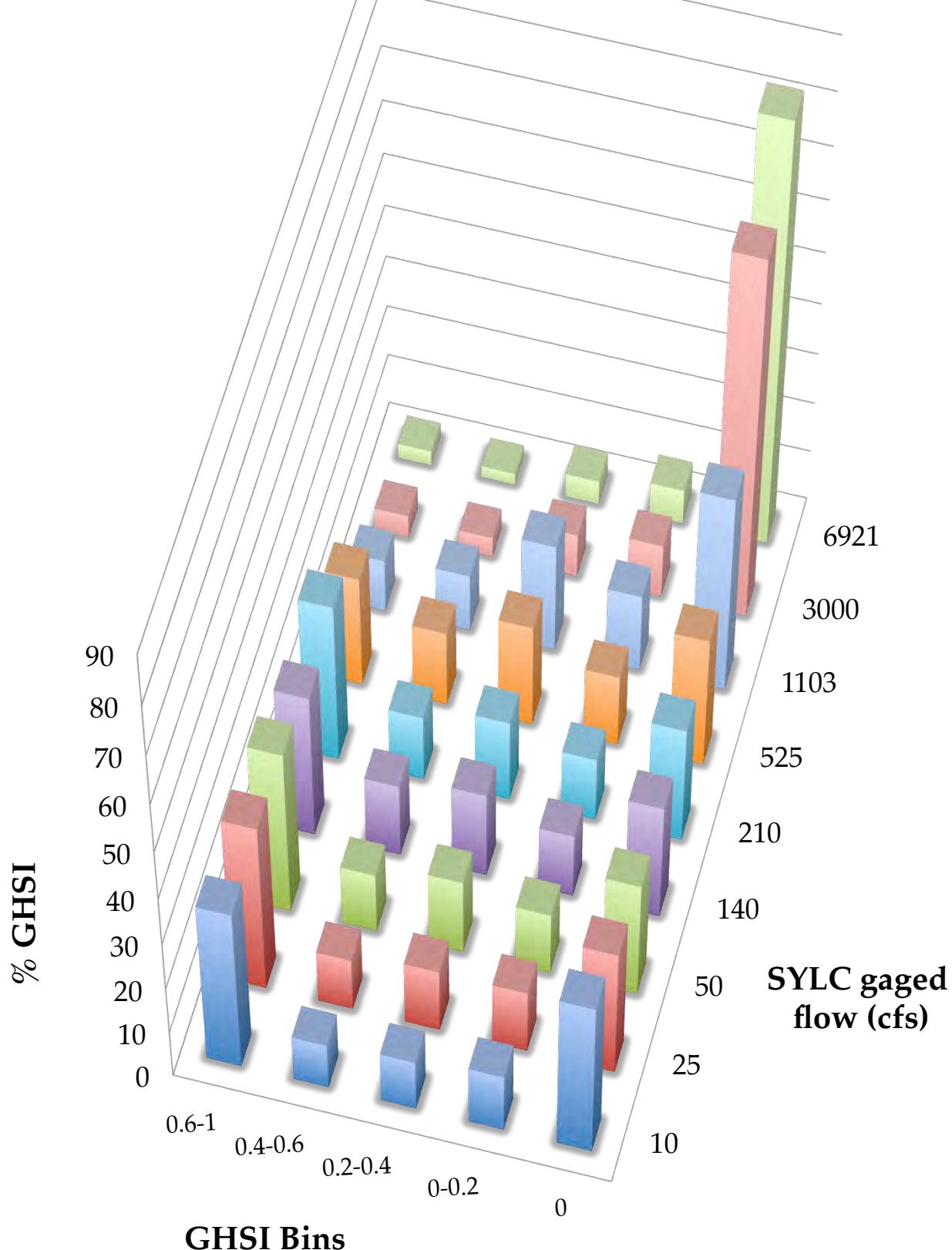
## Adult Sacramento Sucker Snowmelt Season



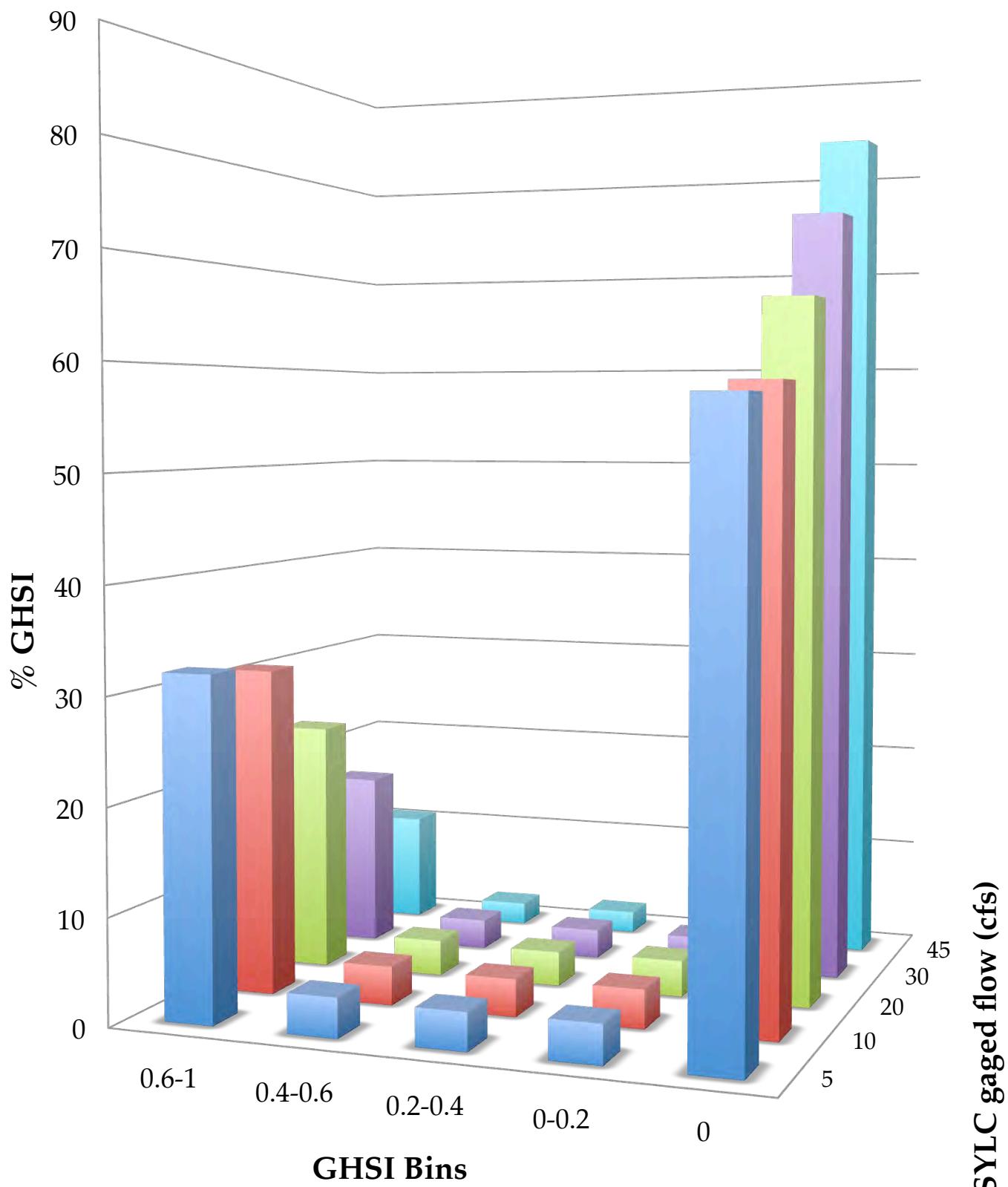
## Adult Rainbow Trout Snowmelt Season



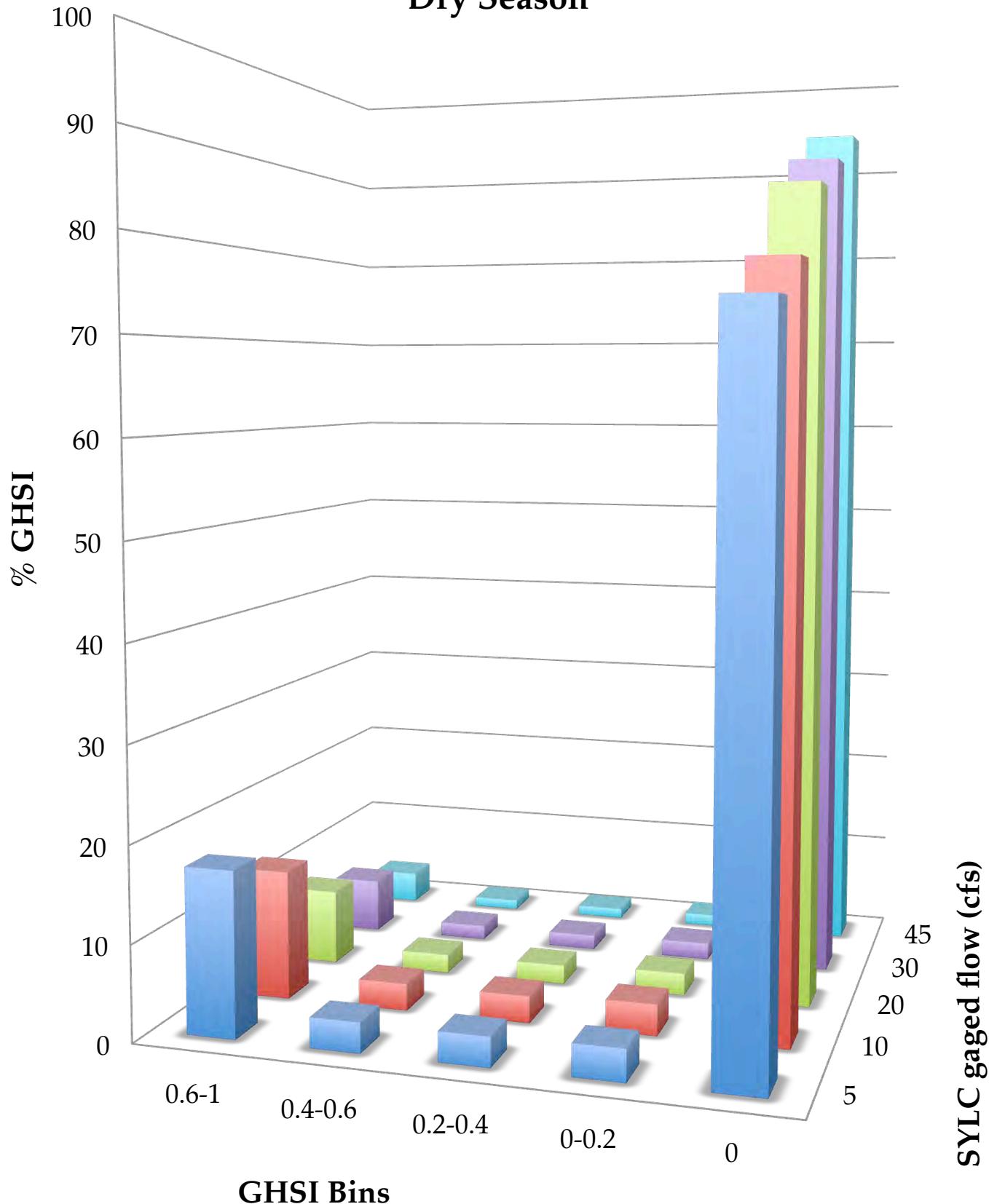
## Adult Pikeminnow/Hardhead Snowmelt Season



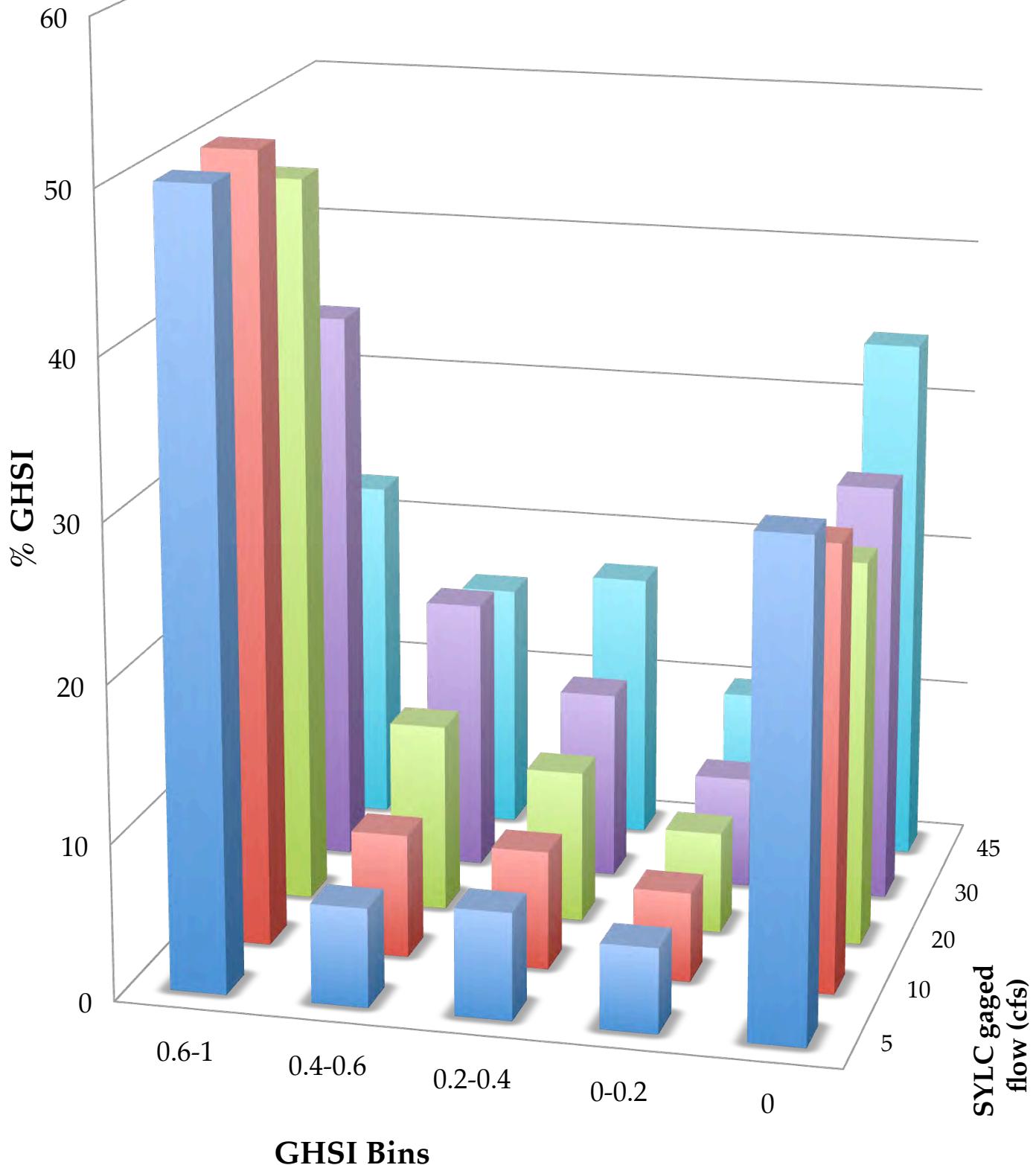
## Juvenile Sacramento Sucker Dry Season



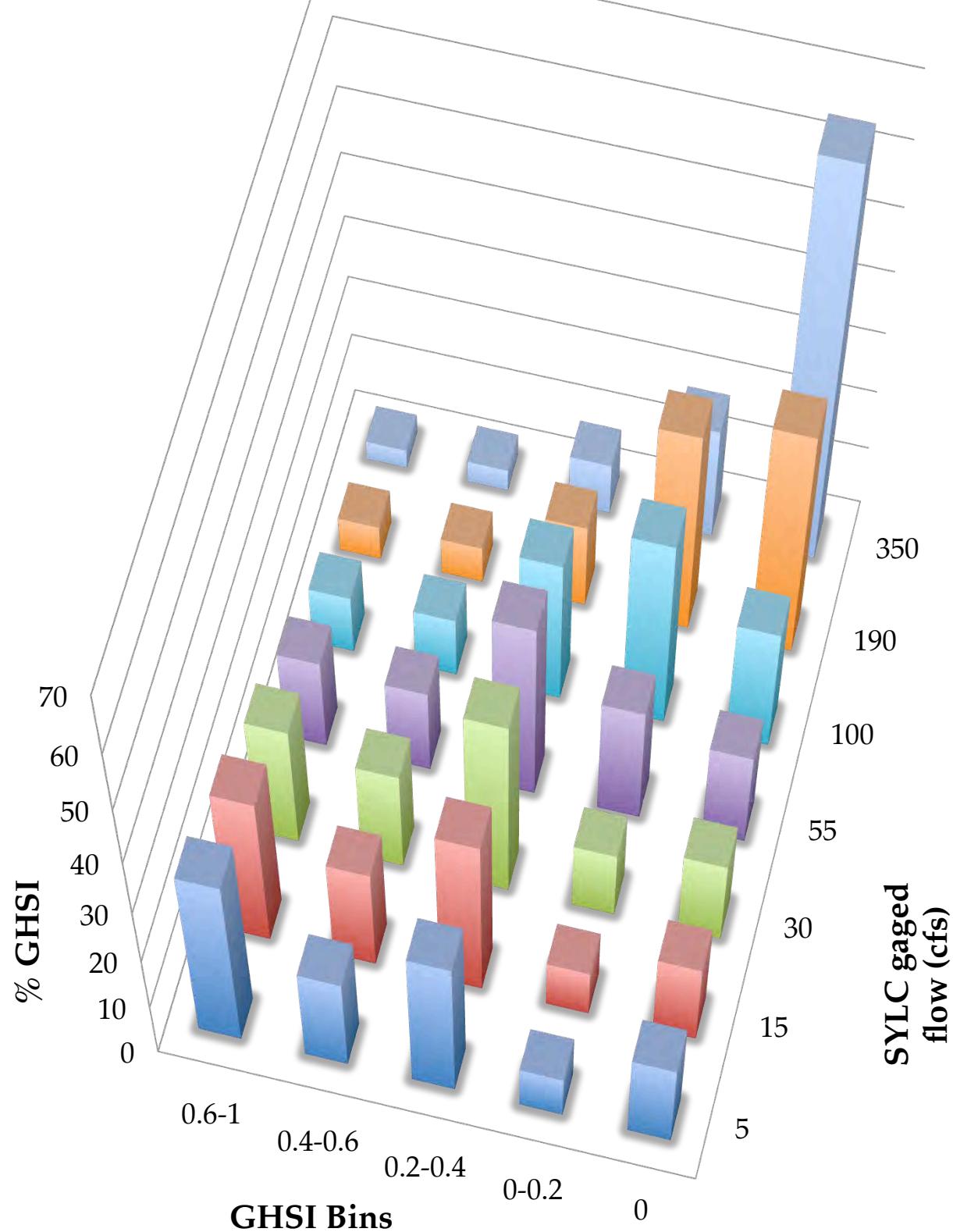
## Juvenile Rainbow Trout Dry Season



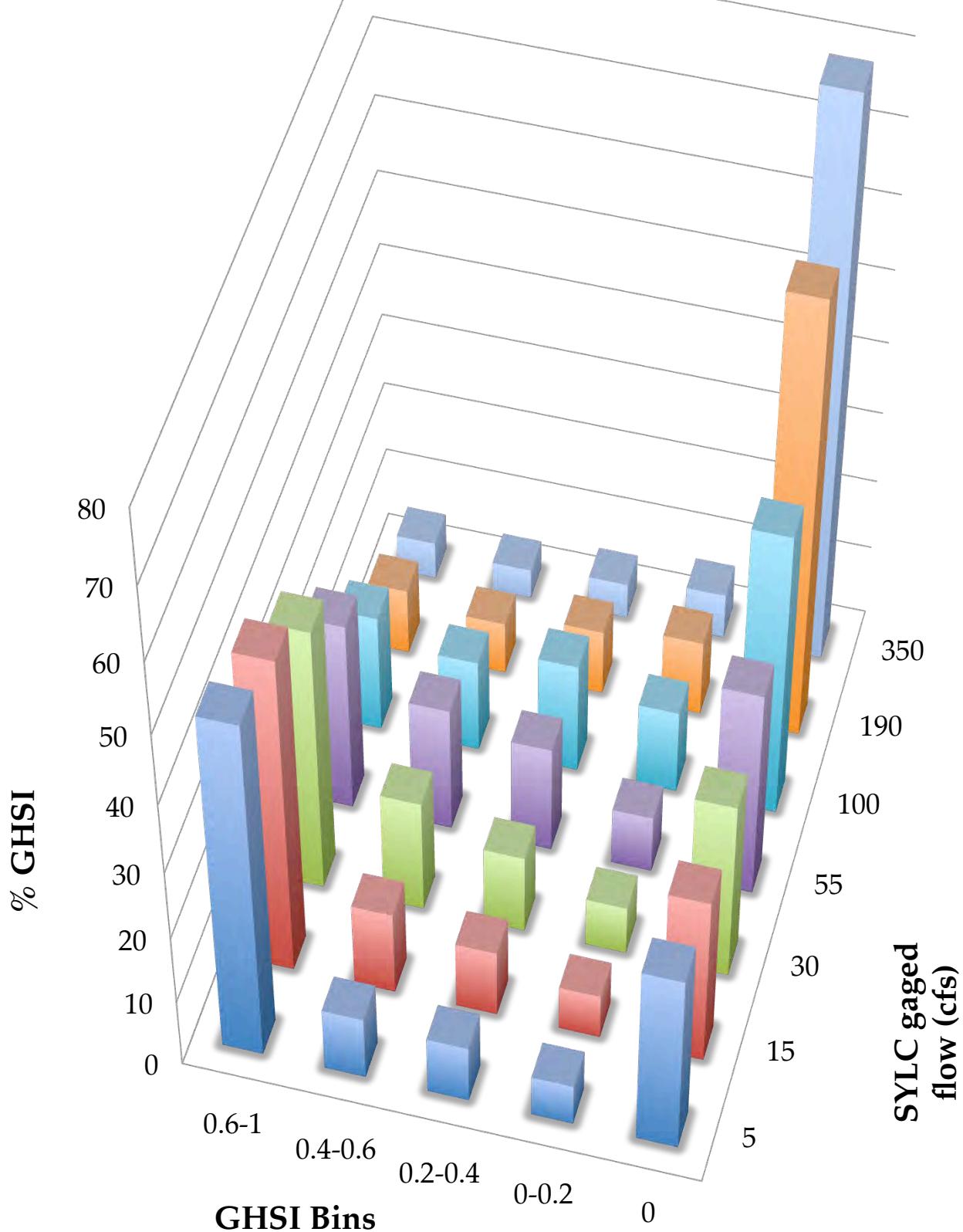
## Juvenile Pikeminnow/Hardhead Dry Season



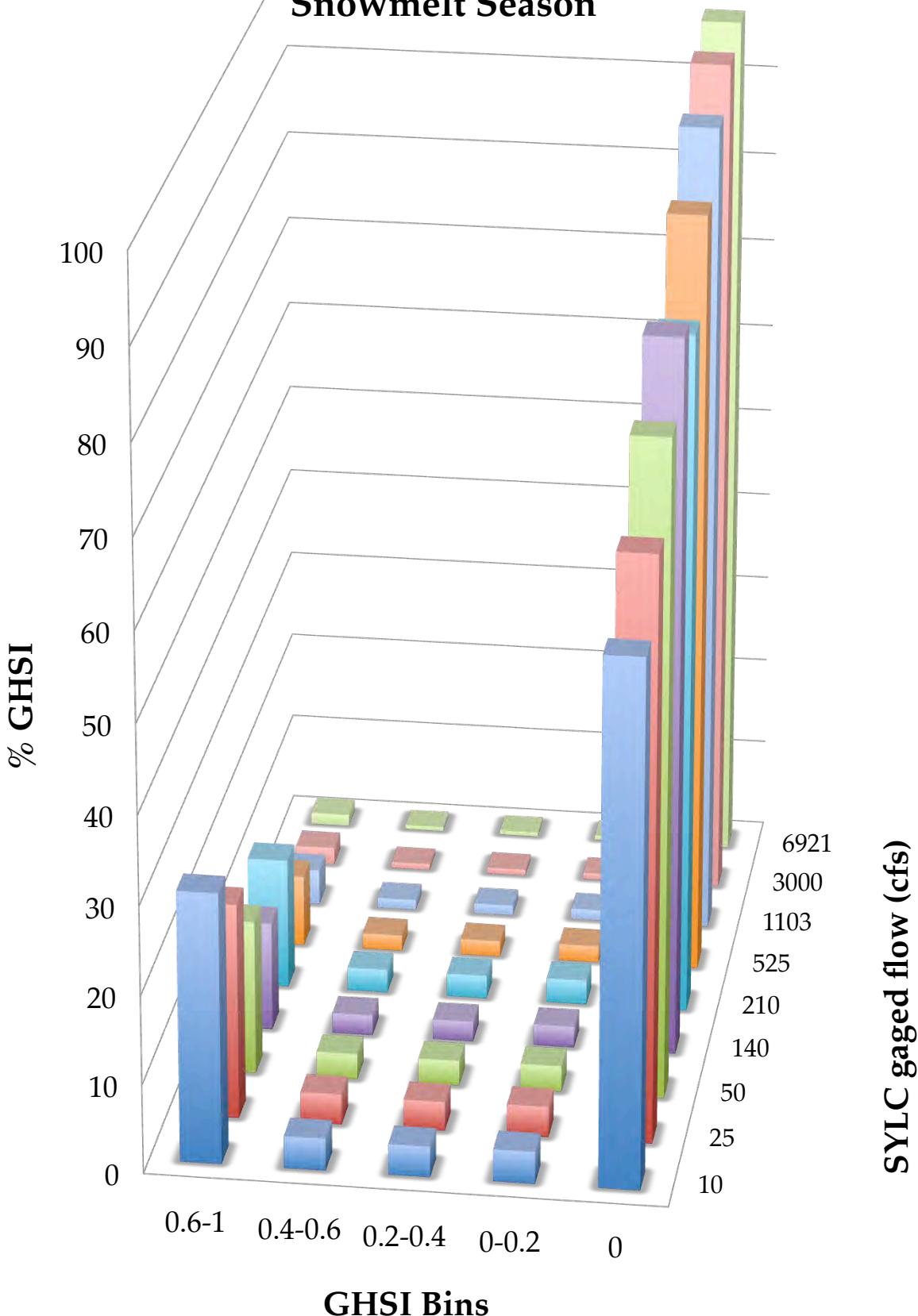
## Juvenile Rainbow Trout Wet Season



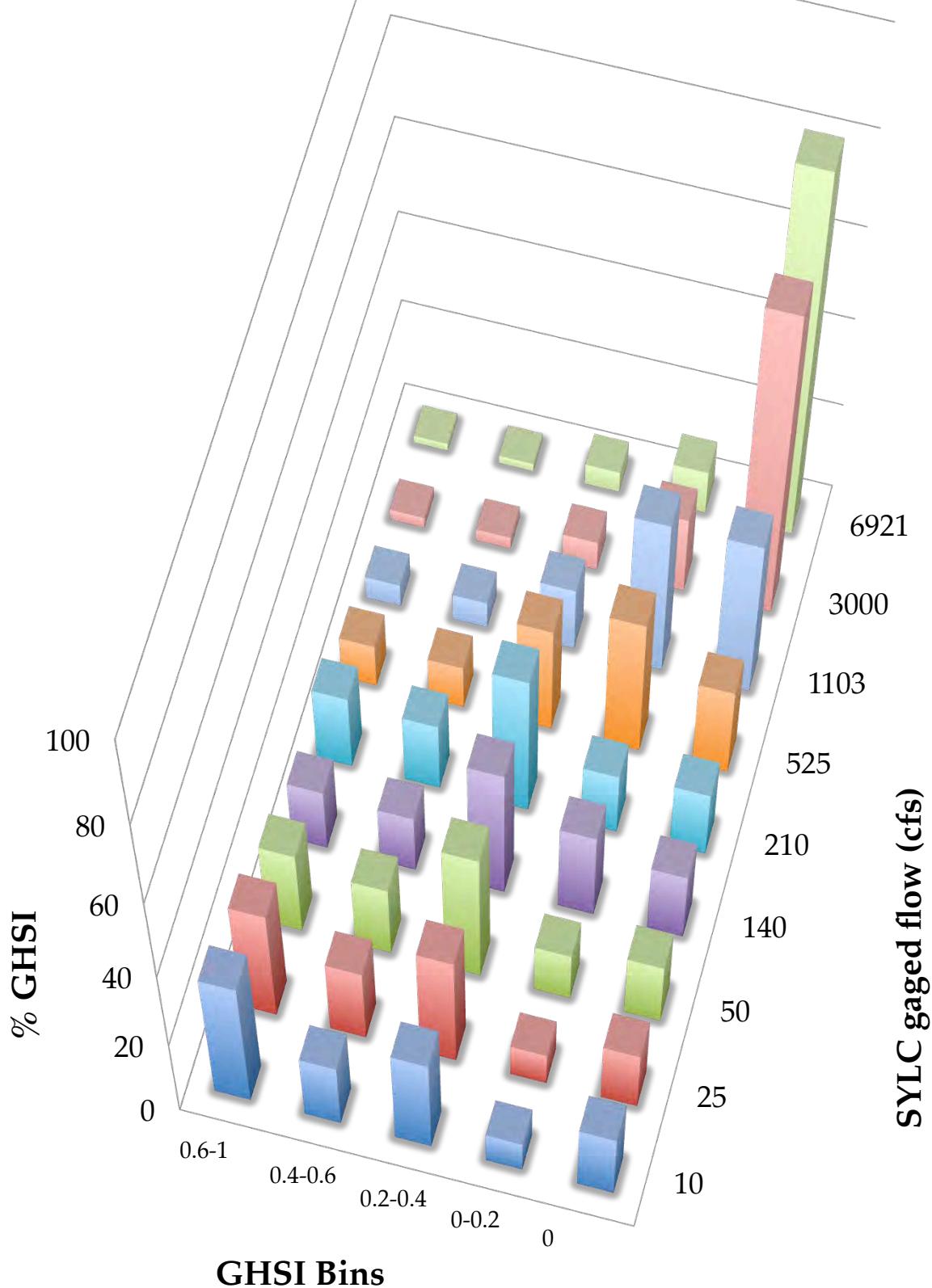
## Juvenile Pikeminnow/Hardhead Wet Season



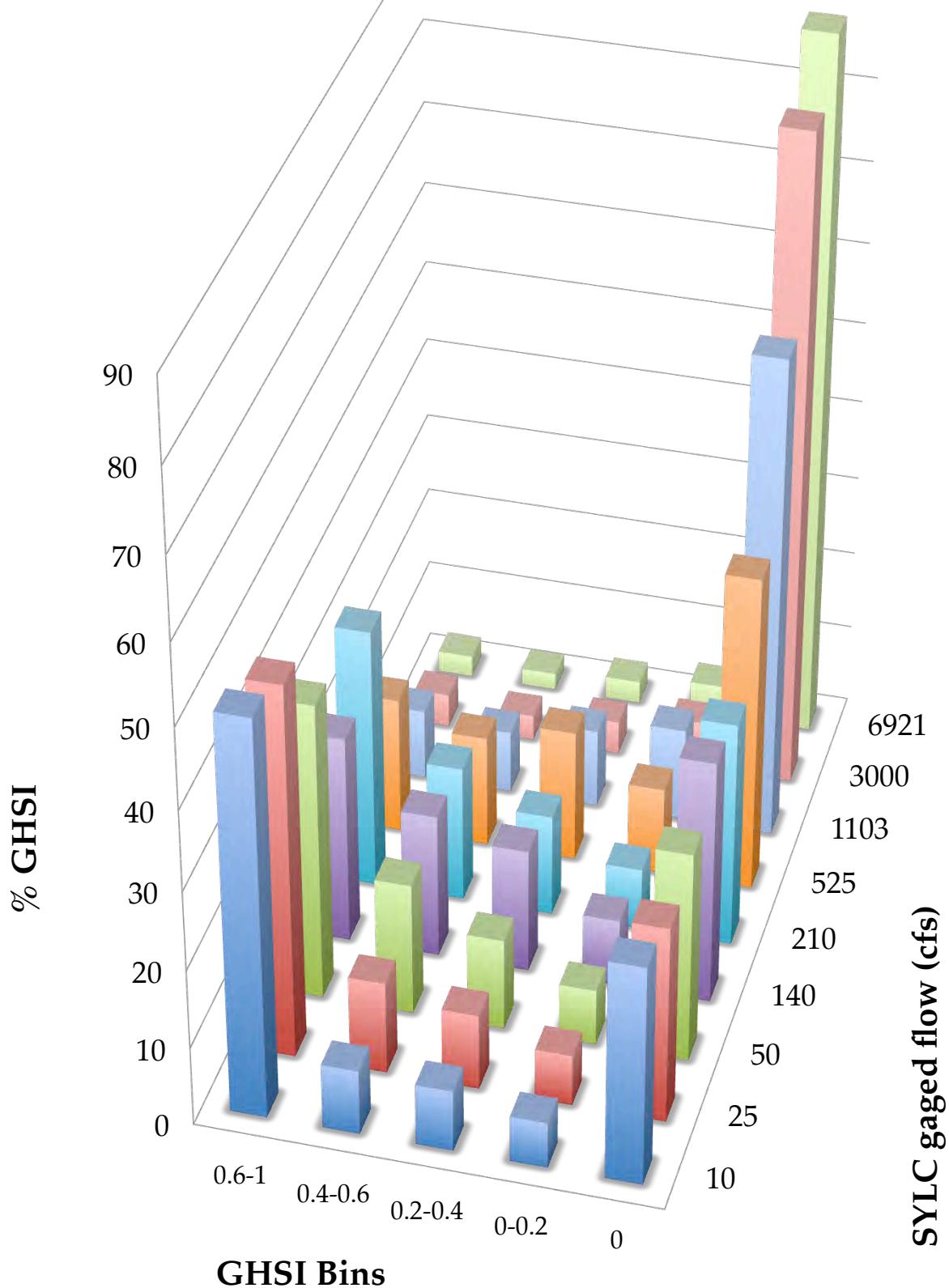
## Juvenile Sacramento Sucker Snowmelt Season



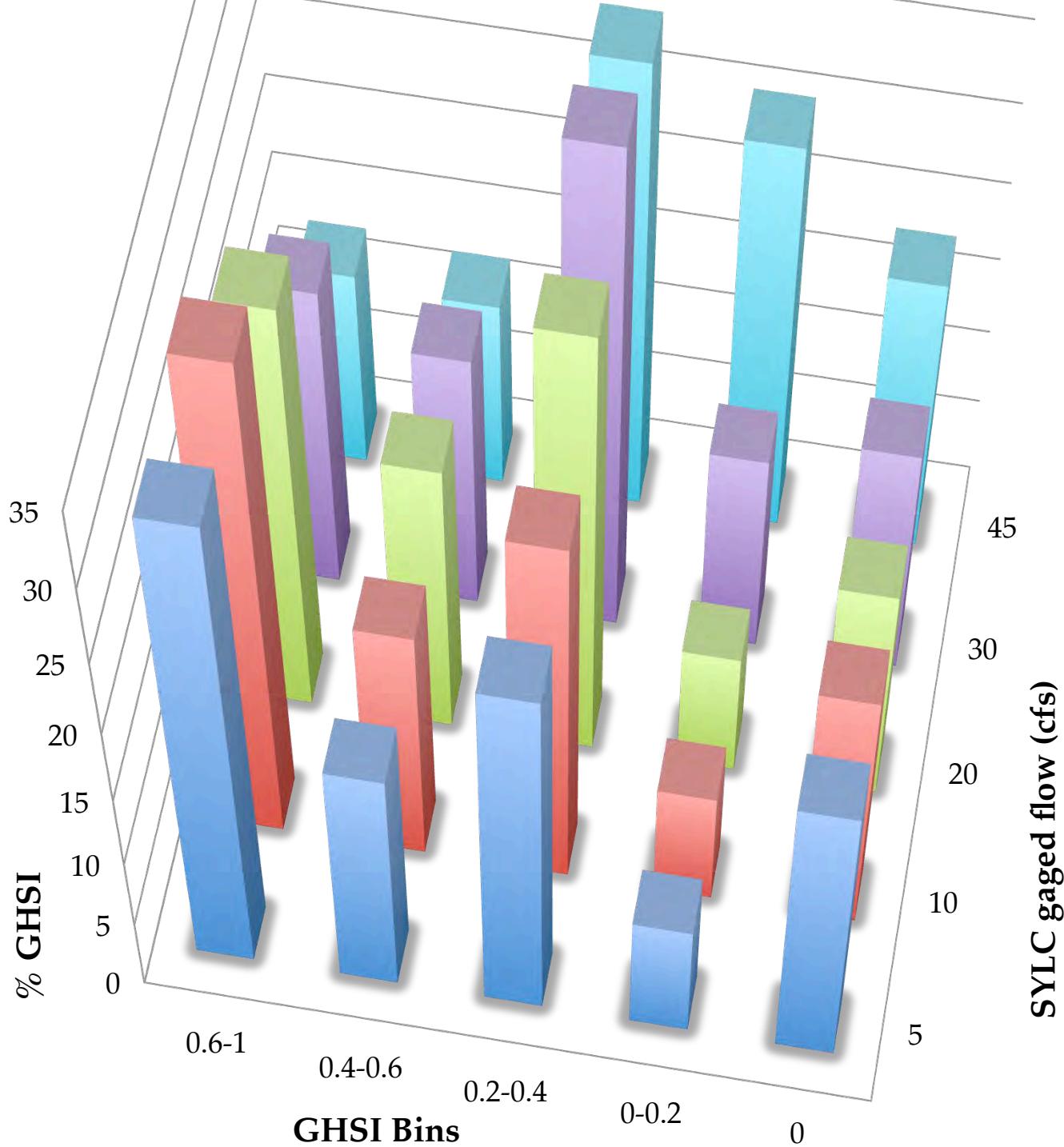
## Juvenile Rainbow Trout Snowmelt Season



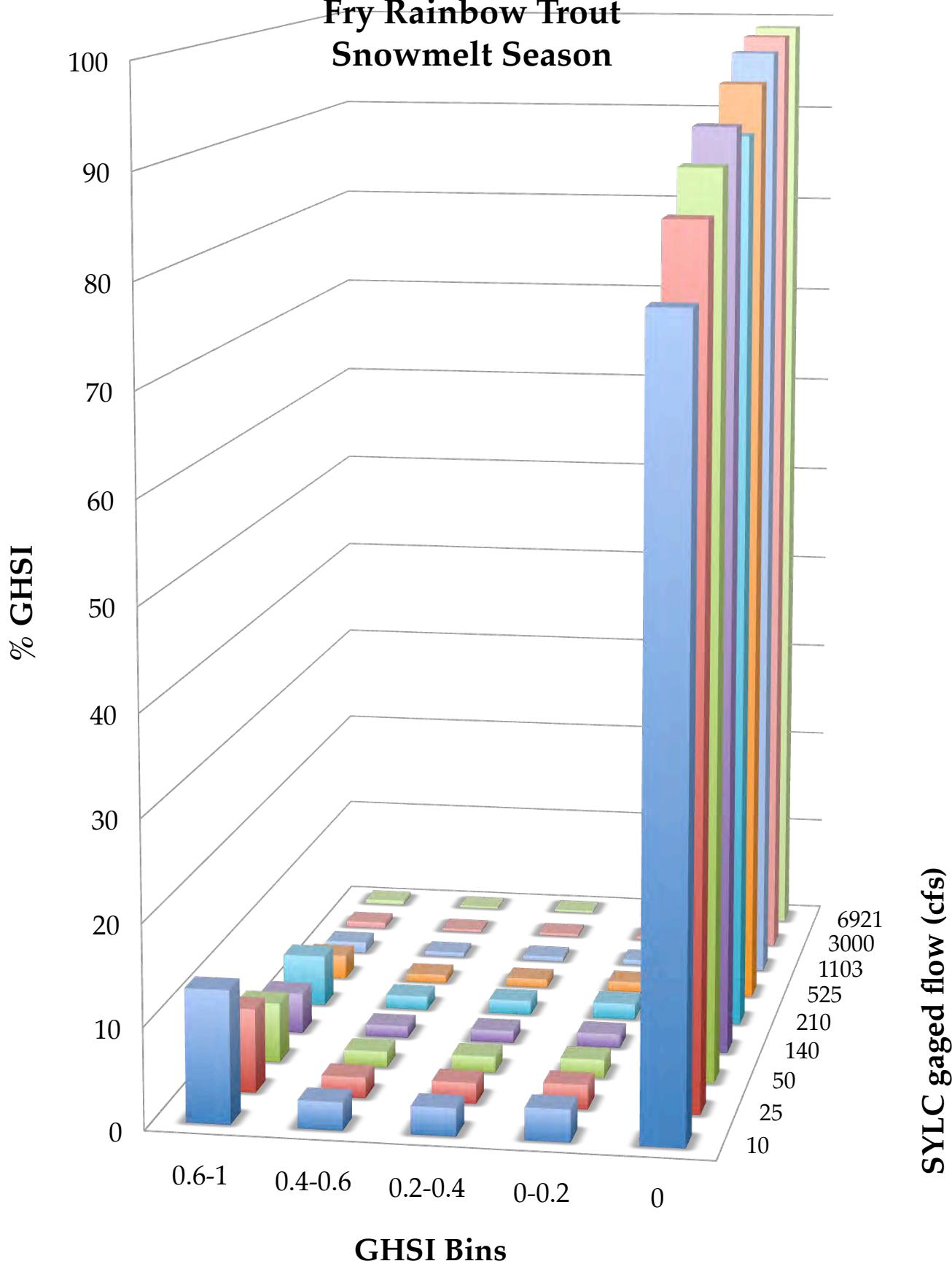
## Juvenile Pikeminnow/Hardhead Snowmelt Season



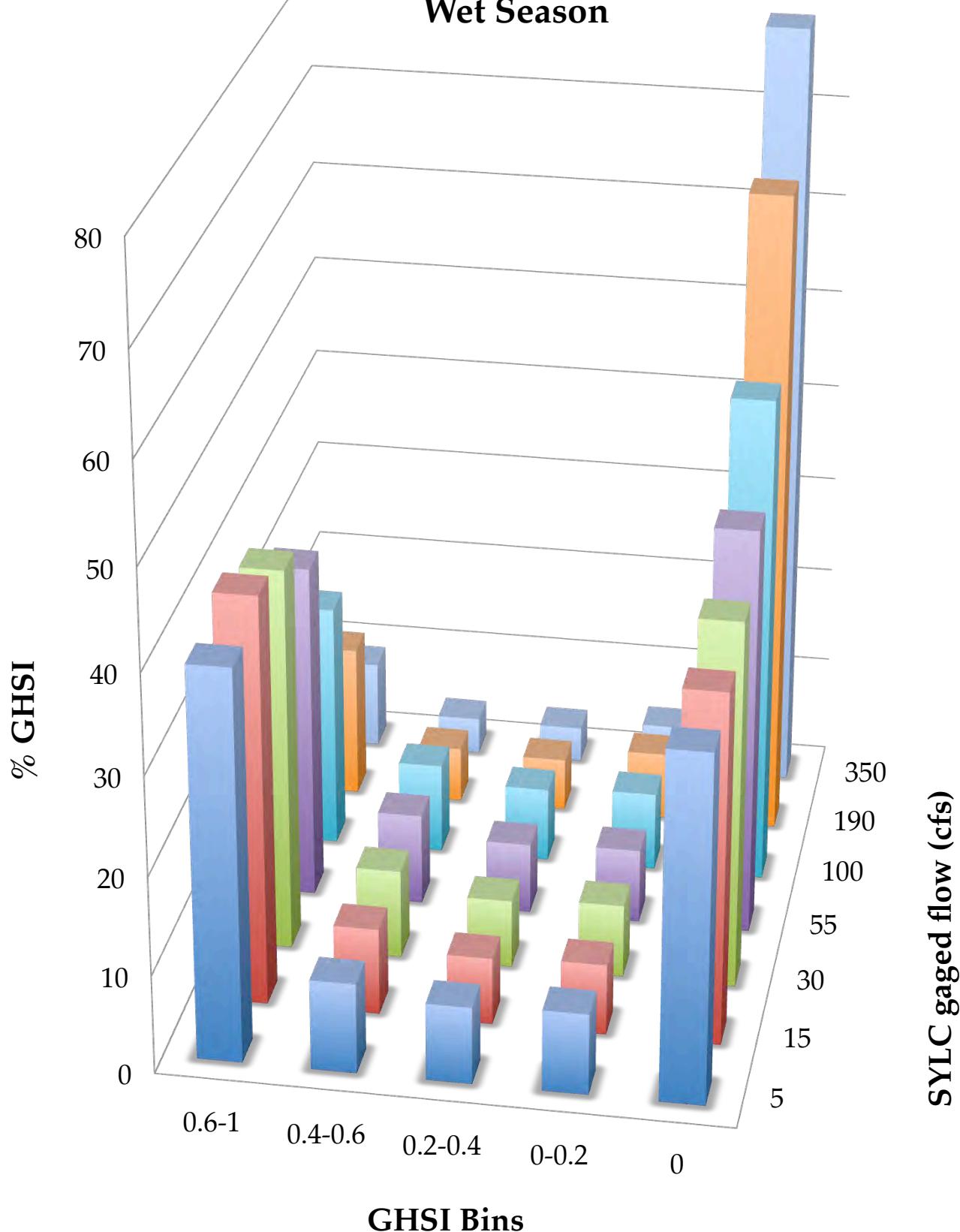
## Fry Rainbow Trout Dry Season



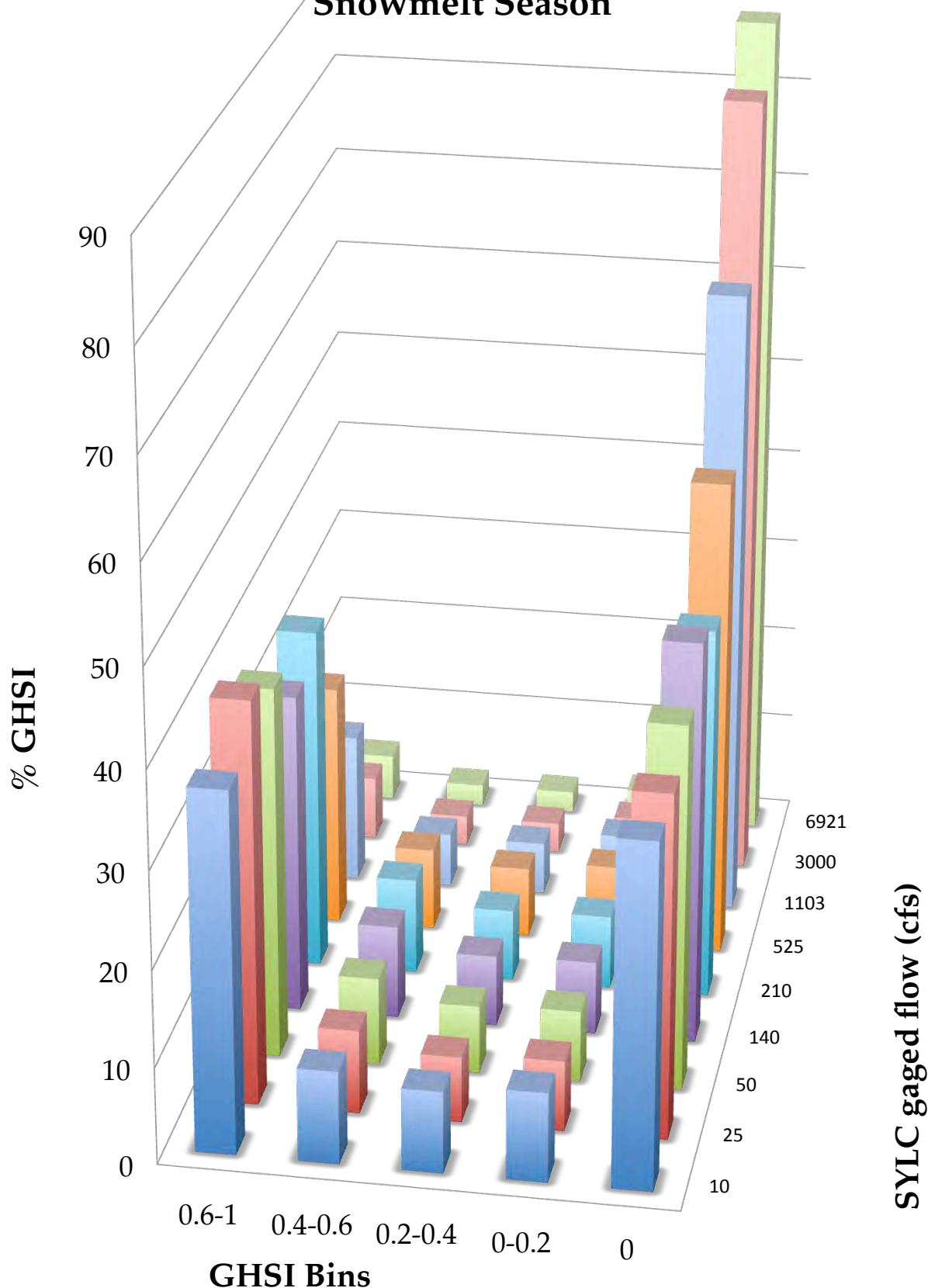
## Fry Rainbow Trout Snowmelt Season



## Spawning Rainbow Trout Wet Season



## Spawning Rainbow Trout Snowmelt Season



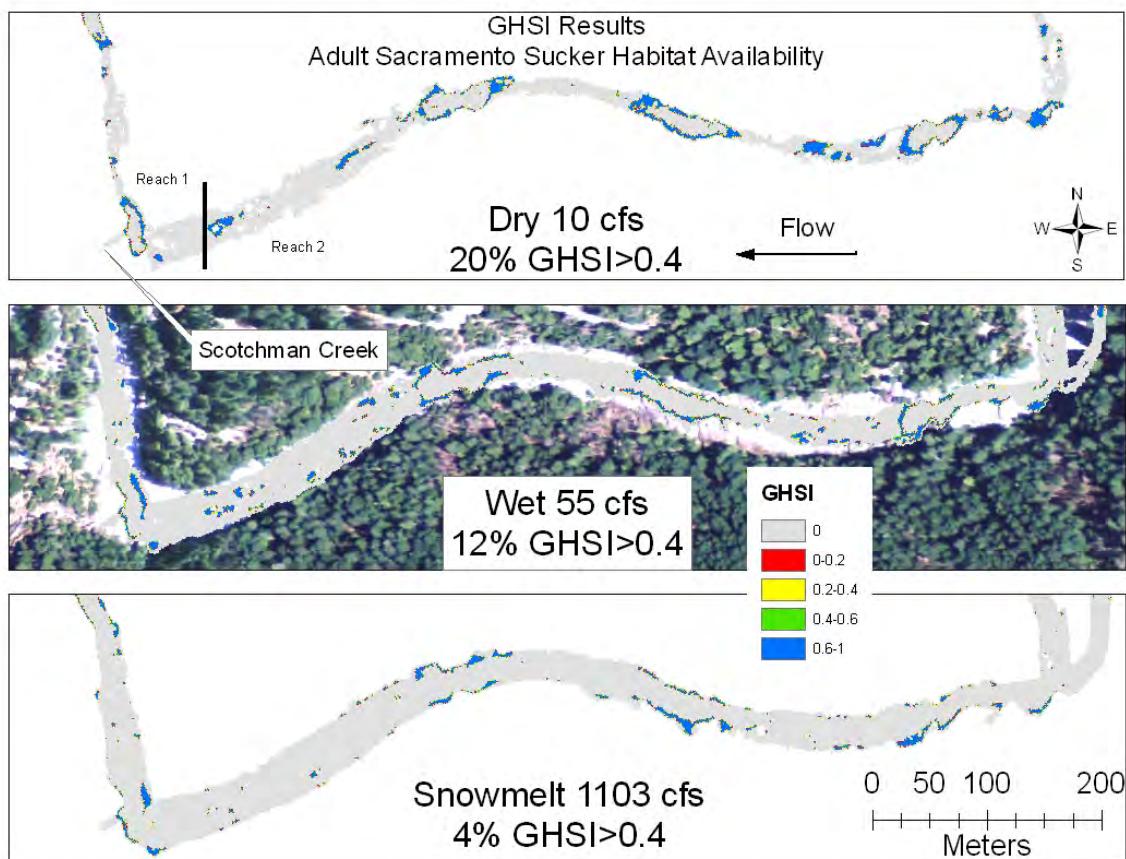
**APPENDIX C:**  
**Visual representation of GHSI % distribution of every species lifestage analyzed in section 11.0 Ecological Analysis**

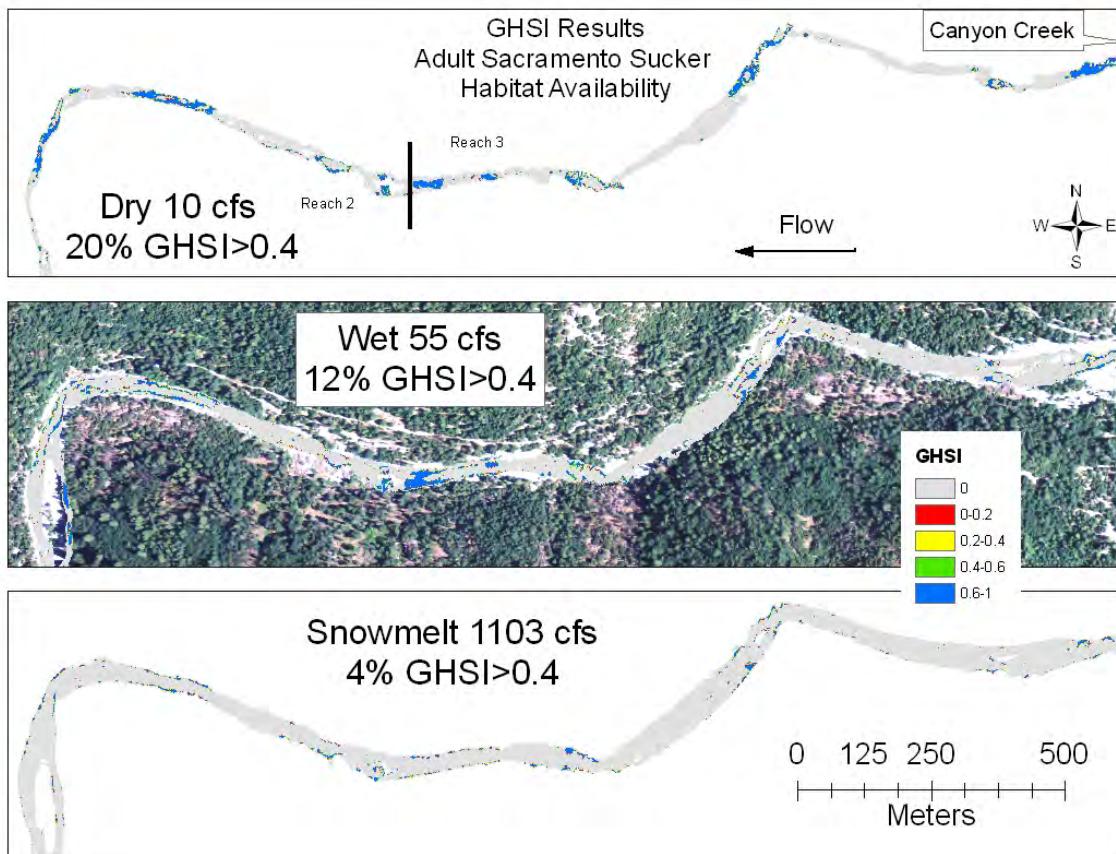
## Appendix C

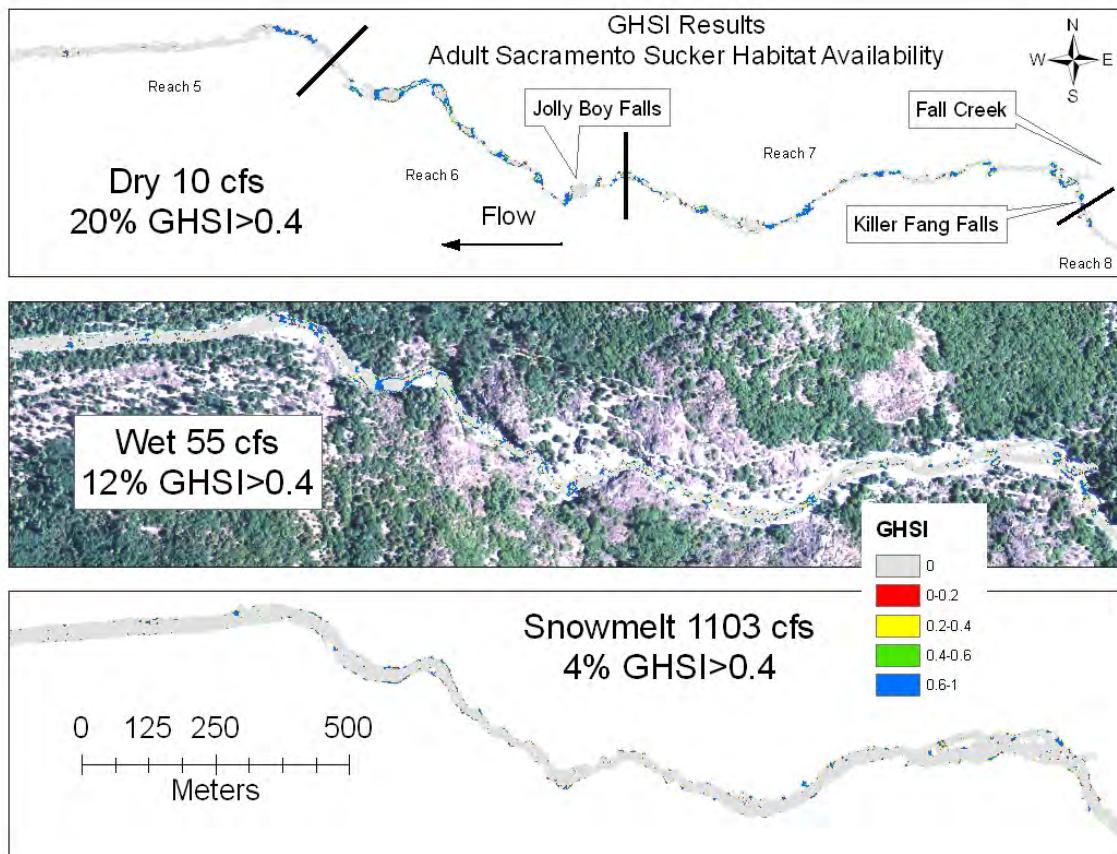
Visual representation of GHSI % distribution of every species lifestage analyzed in section 11.0 Ecological Analysis (see Table 42).

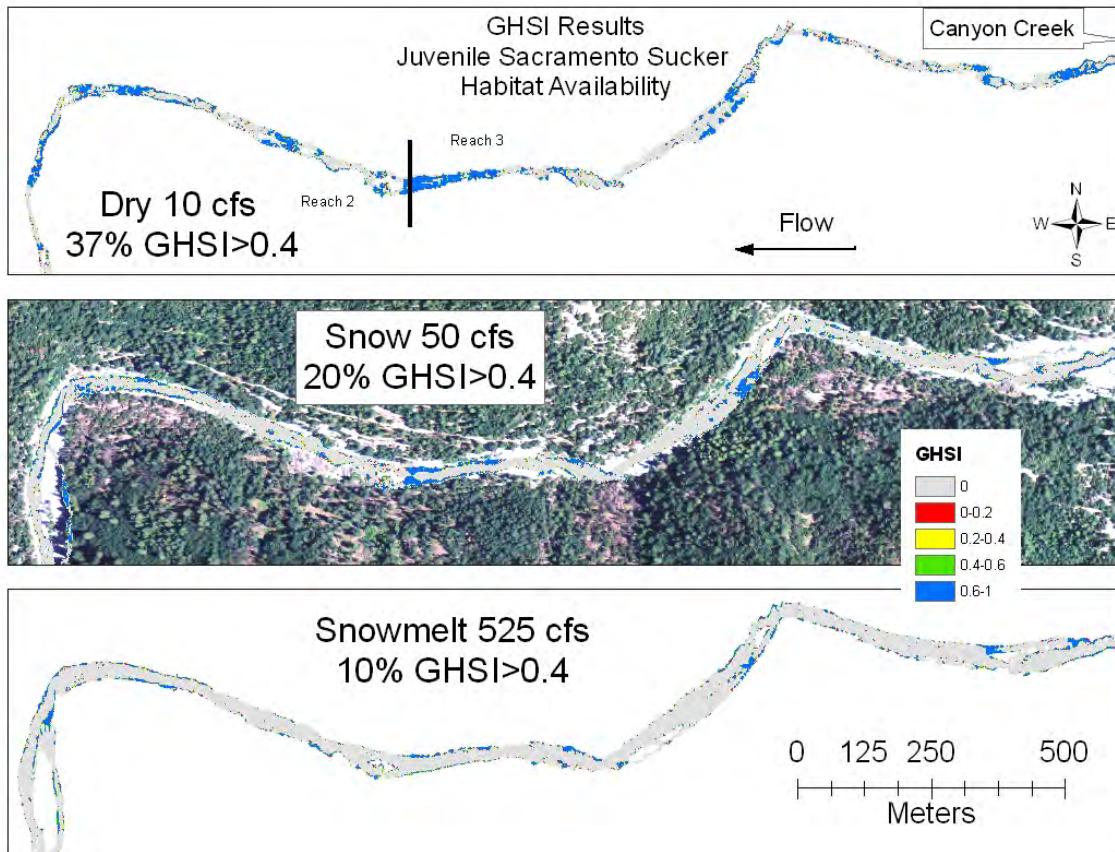
Each *image* consists of a set of three depictions, as can be seen here on APC-1. Each species lifestage is represented at three flows, which correspond to three GHSI values. The top panel depicts the highest % of preferred area for the specific lifestage. Middle panel depicts a mid-range % of preferred area. Lower panel depicts a low % of preferred habitat. Each lifestage is represented at three flows *and* across three reaches, for a total of 9 visual representations of each species lifestage.

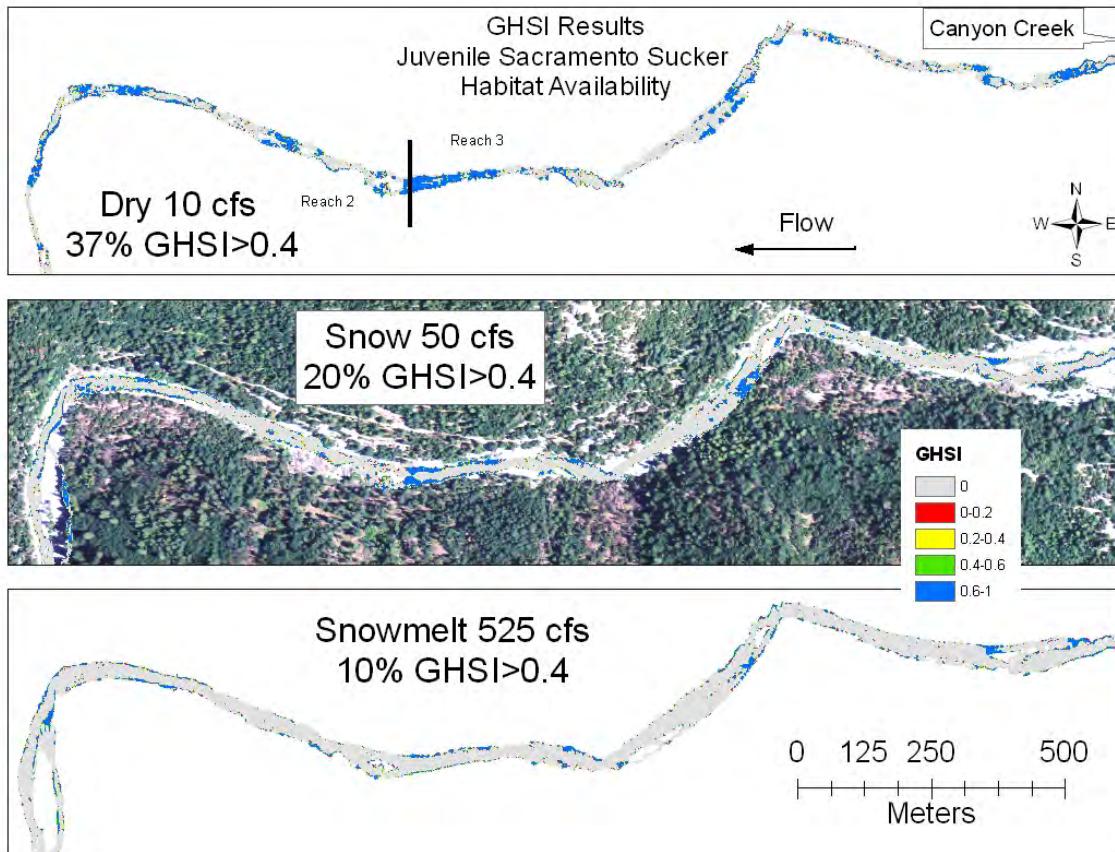
Each *image set* consists of three images. The image sets are ordered by reach, with the first image depicting the upper end of Reach 1 and the lower end of Reach 2 at three flows and the accompanying GHSI values. The second image depicts the upper end of Reach 2 and the lower end of Reach 3. This image stops just below Canyon Creek, thus the first two images encompass much of the accessible river near Washington, CA. The third image depicts all of Reach 6 and 7 and parts of upper Reach 5 and lower Reach 8, includes Jolly Boy and Killer Fang Falls and the confluence of Fall Creek with the mainstem.

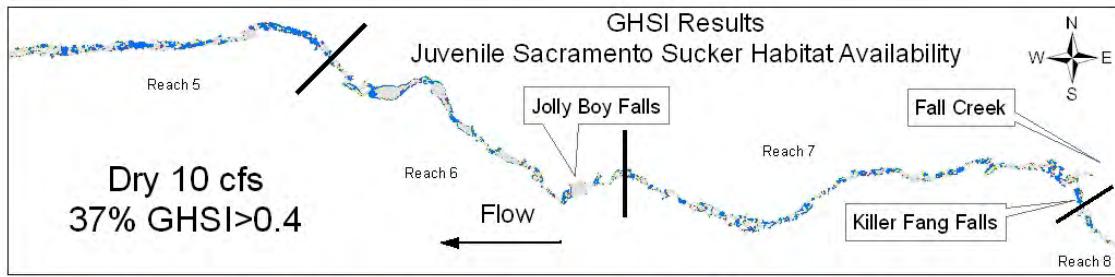


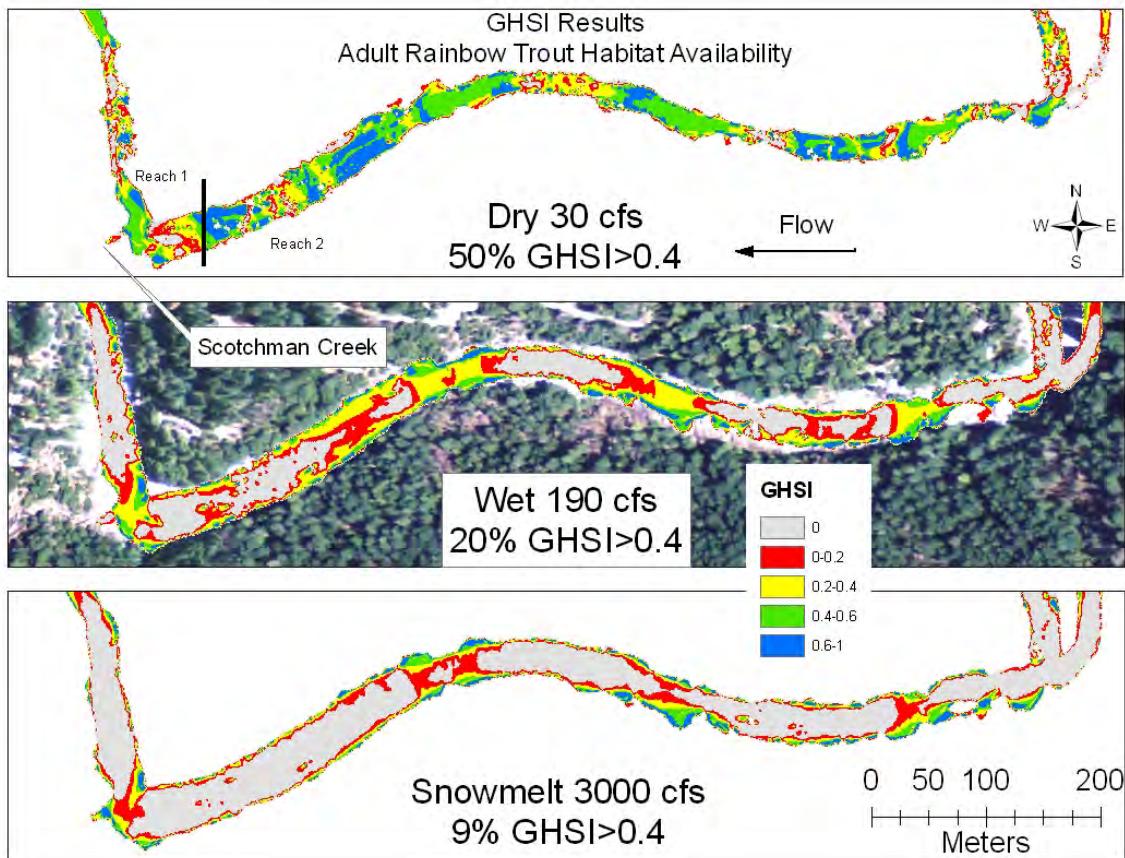


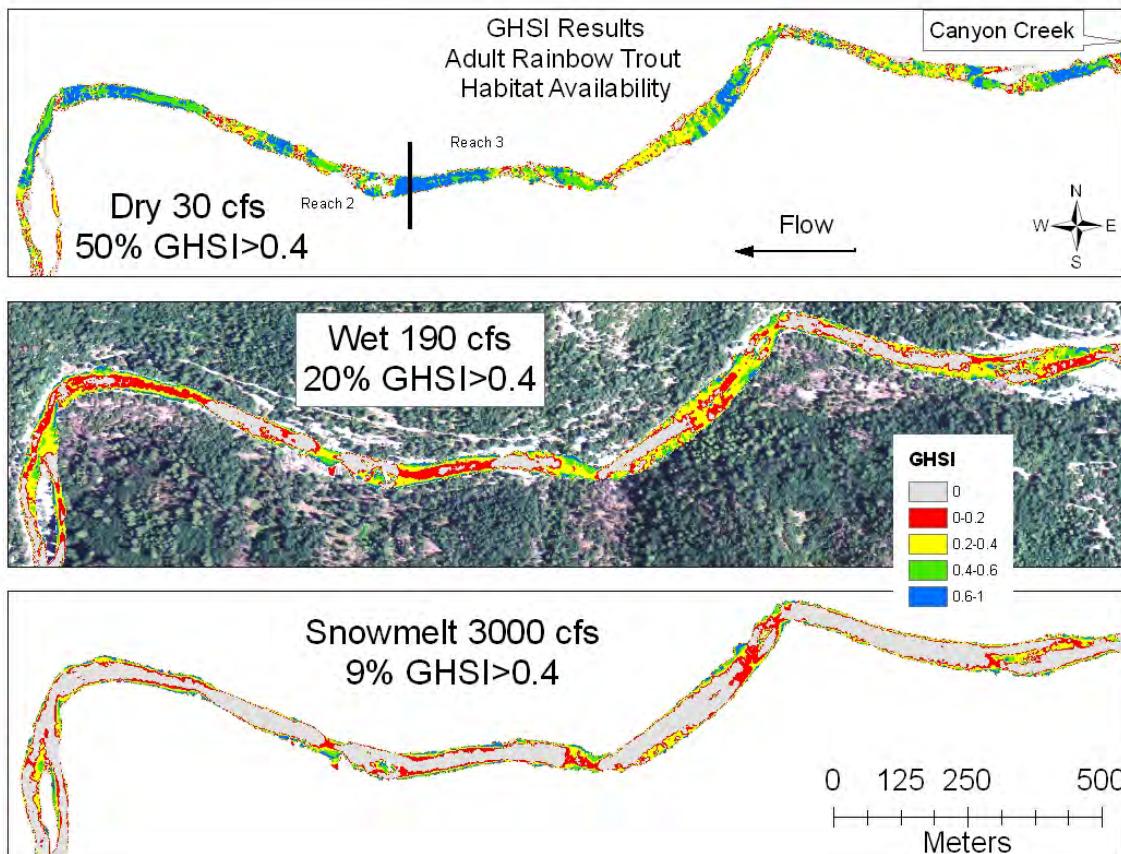


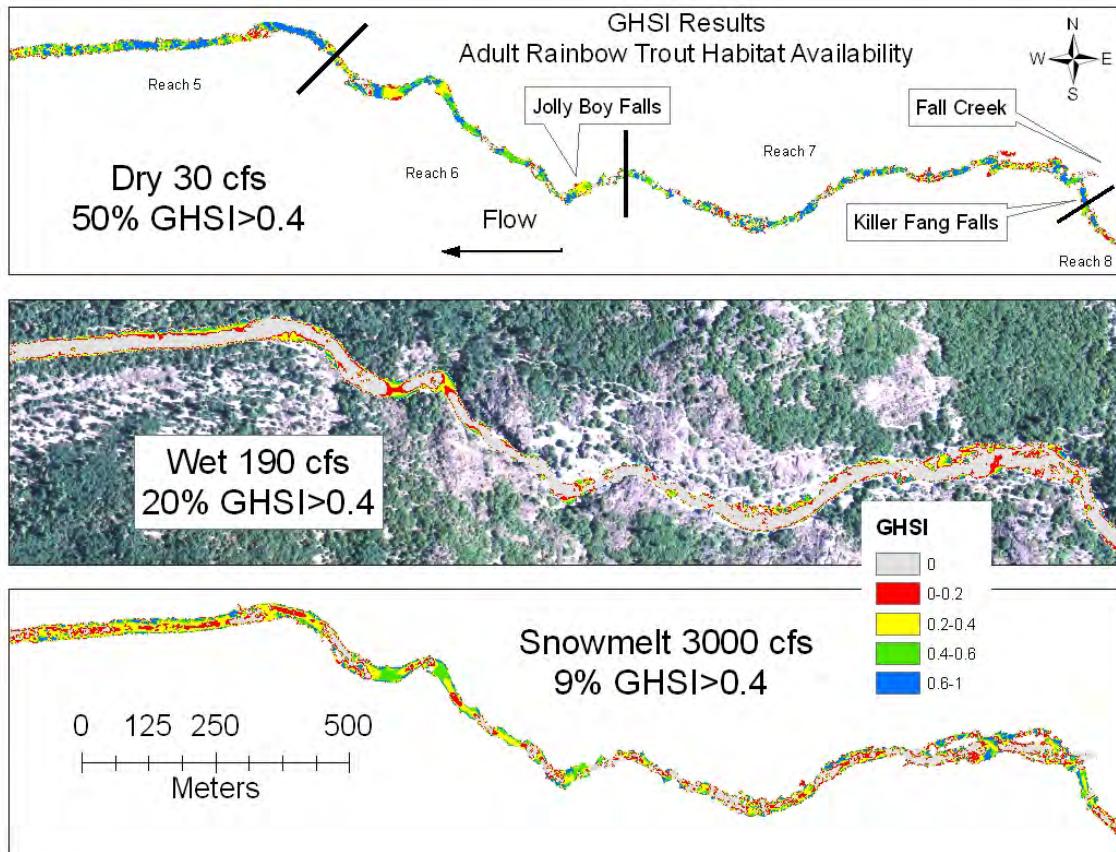


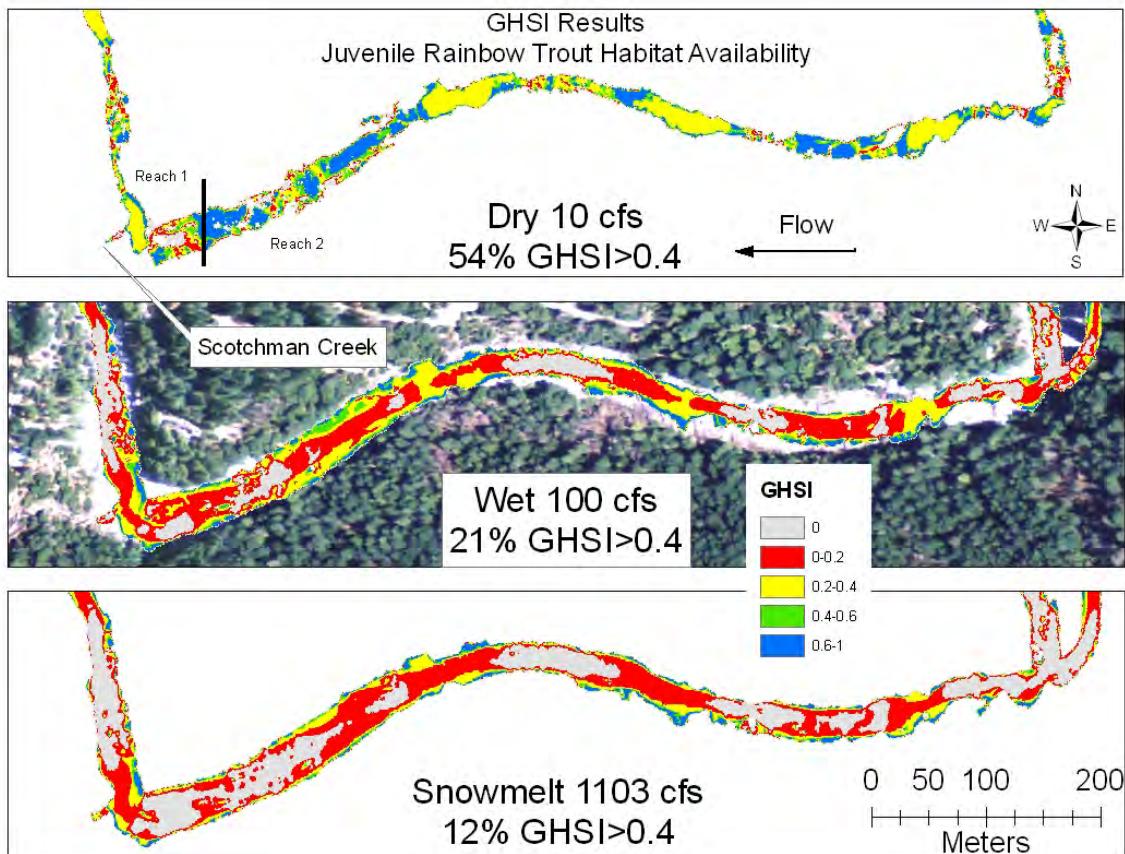


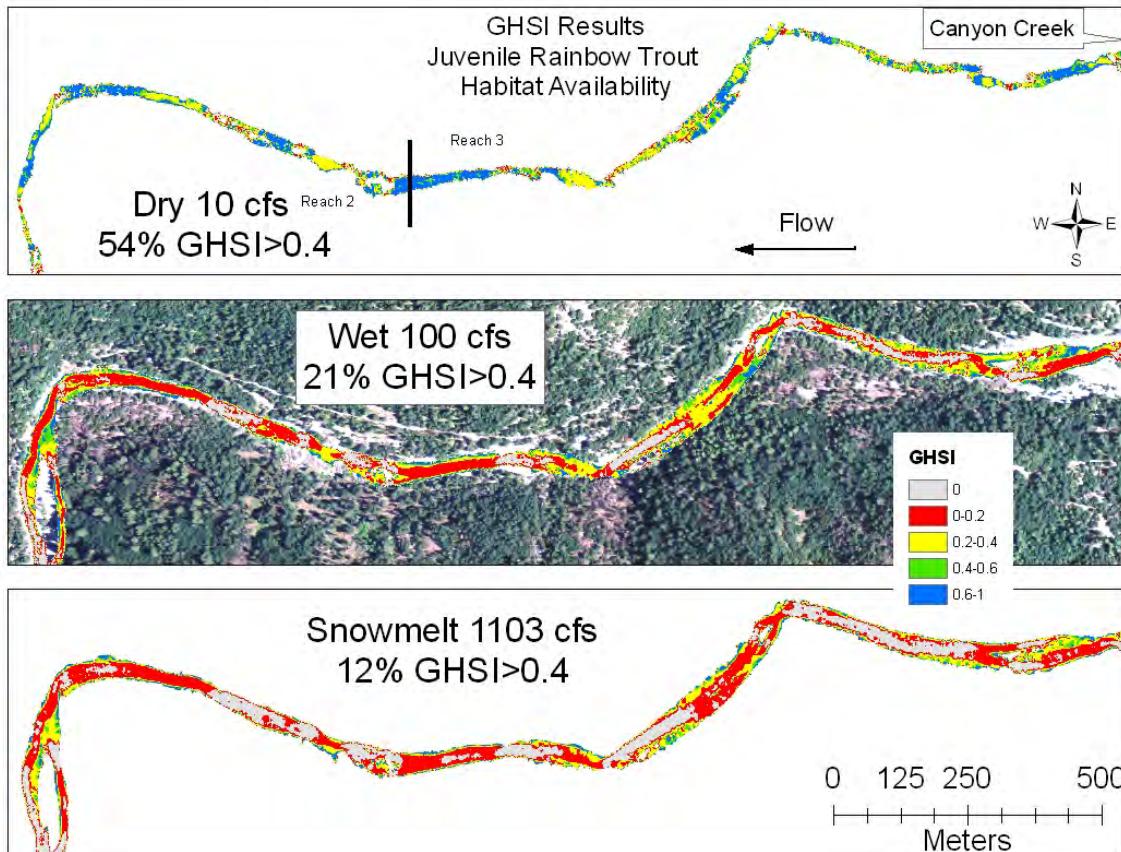


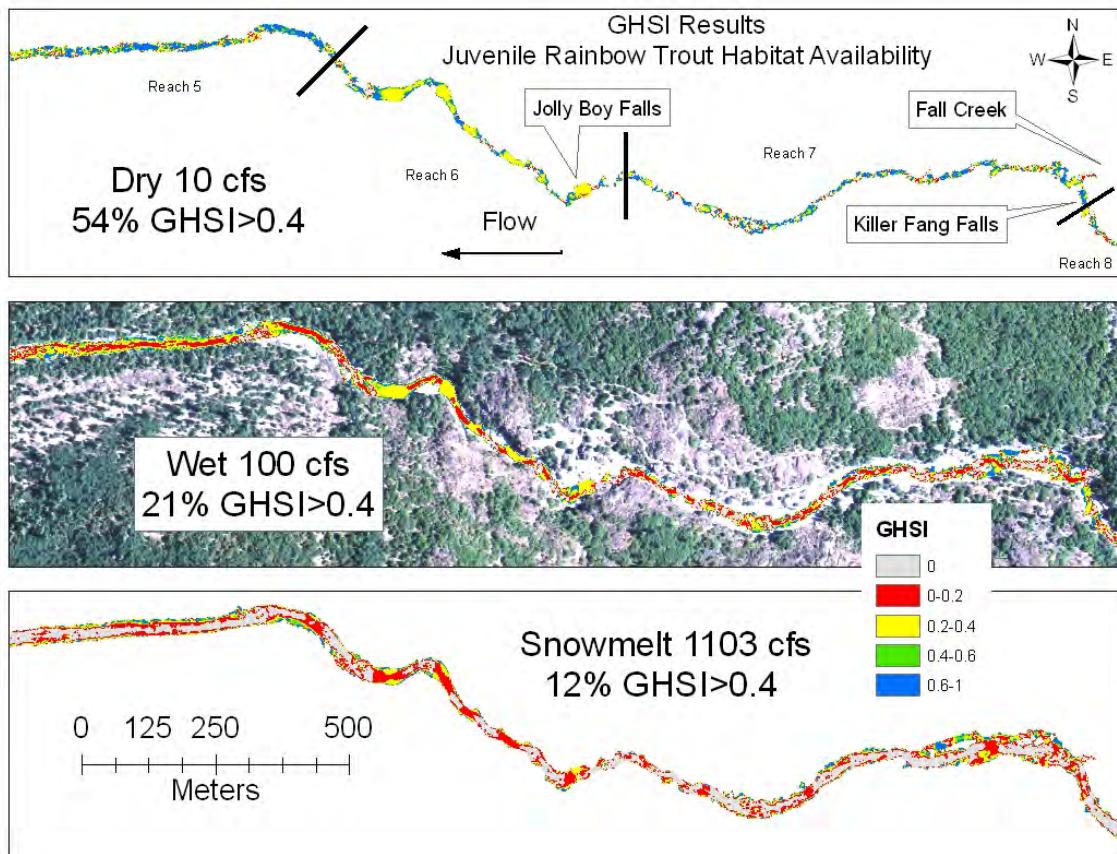


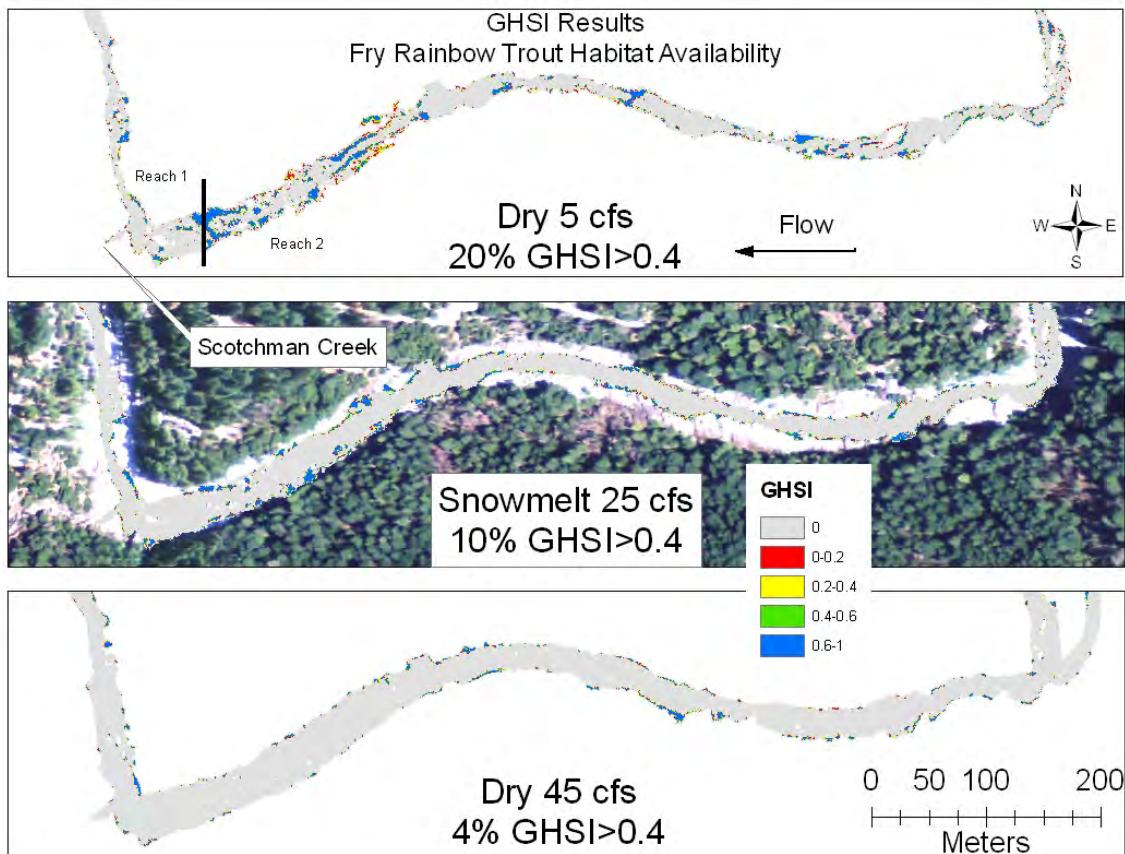


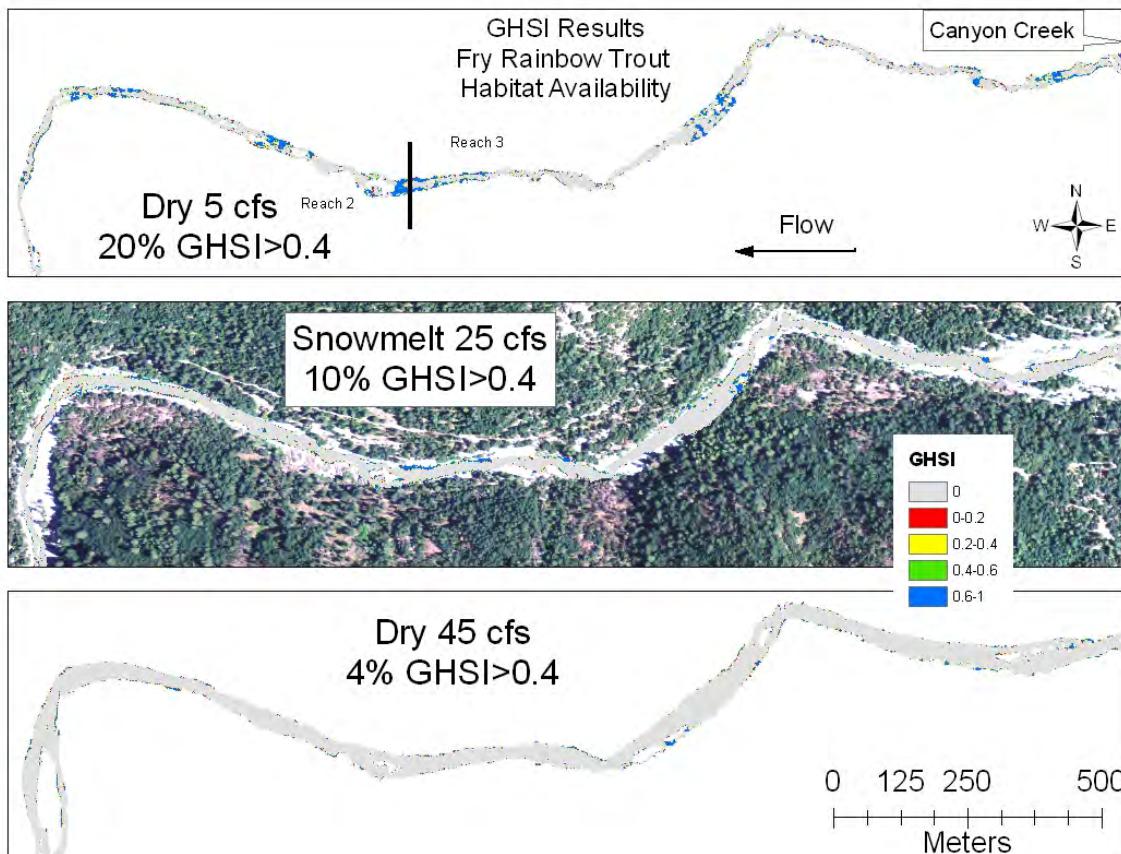


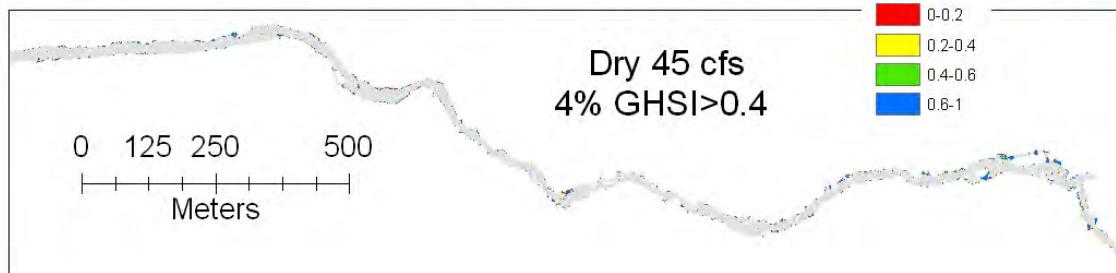
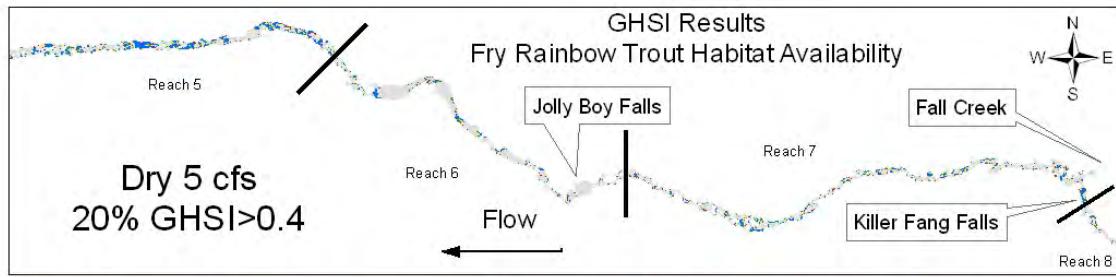


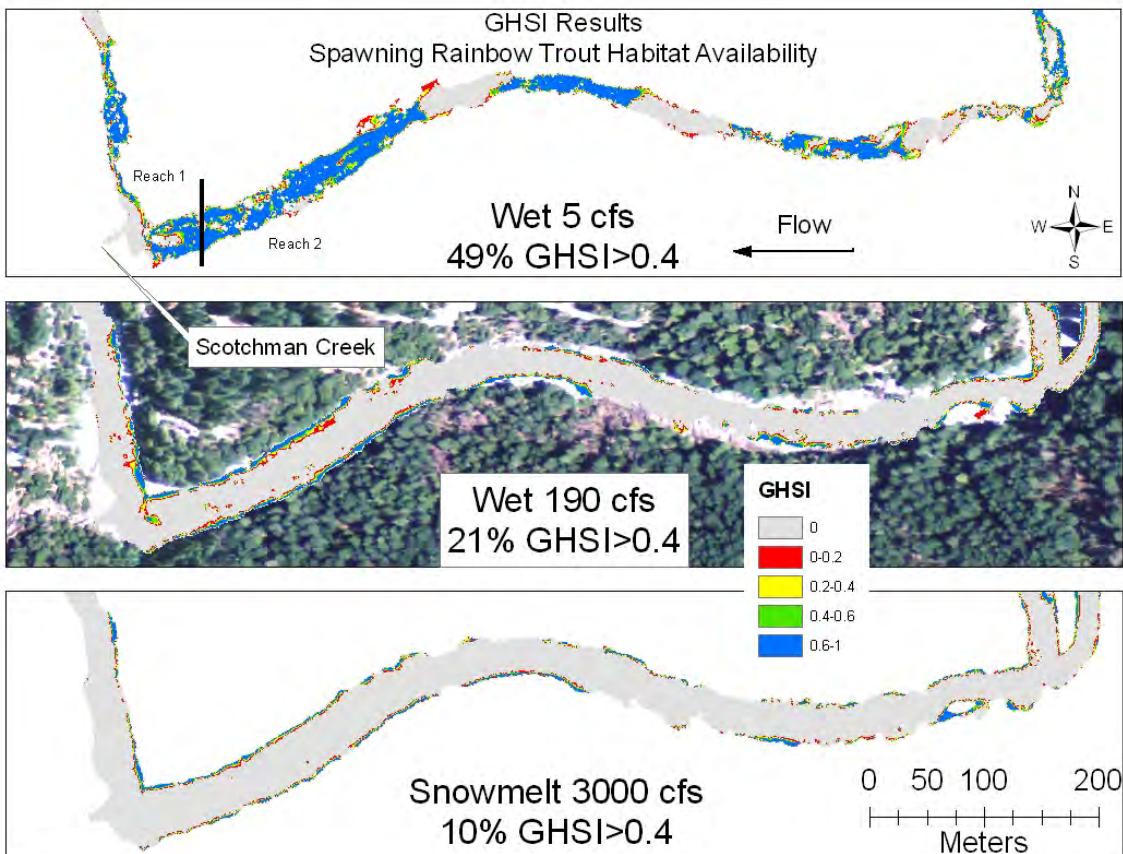


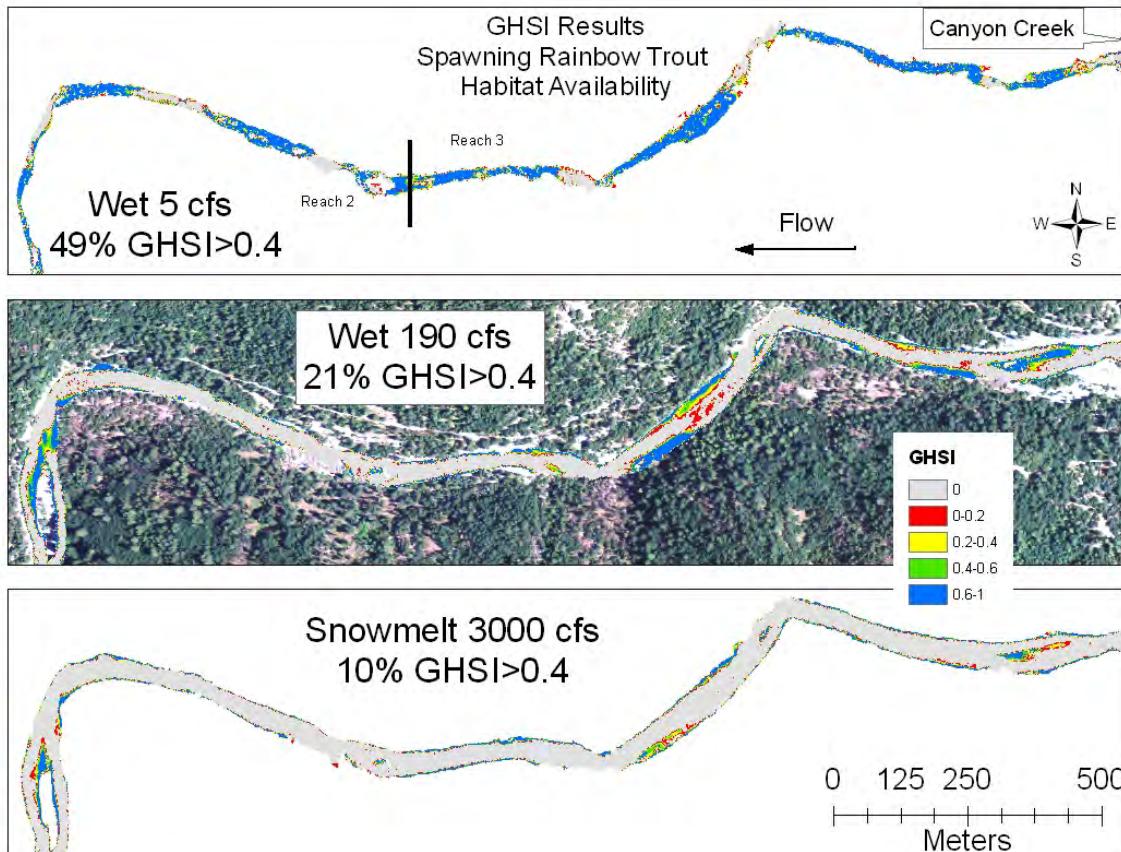


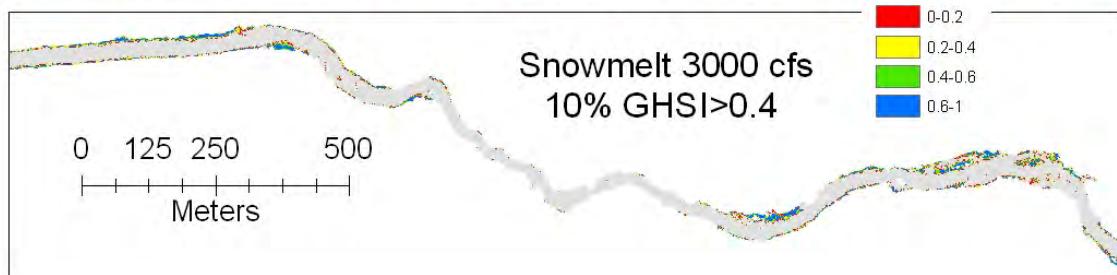
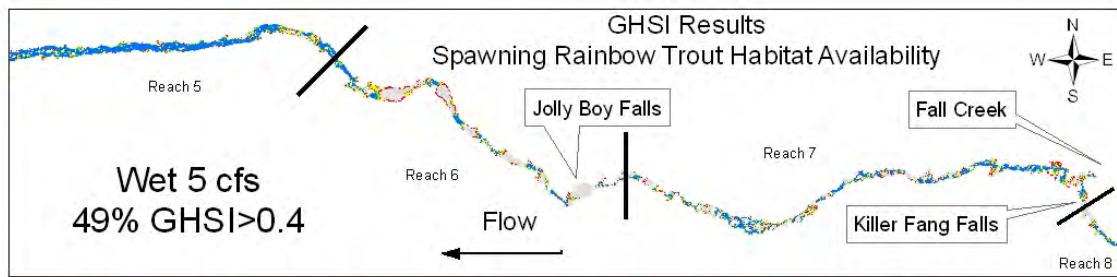


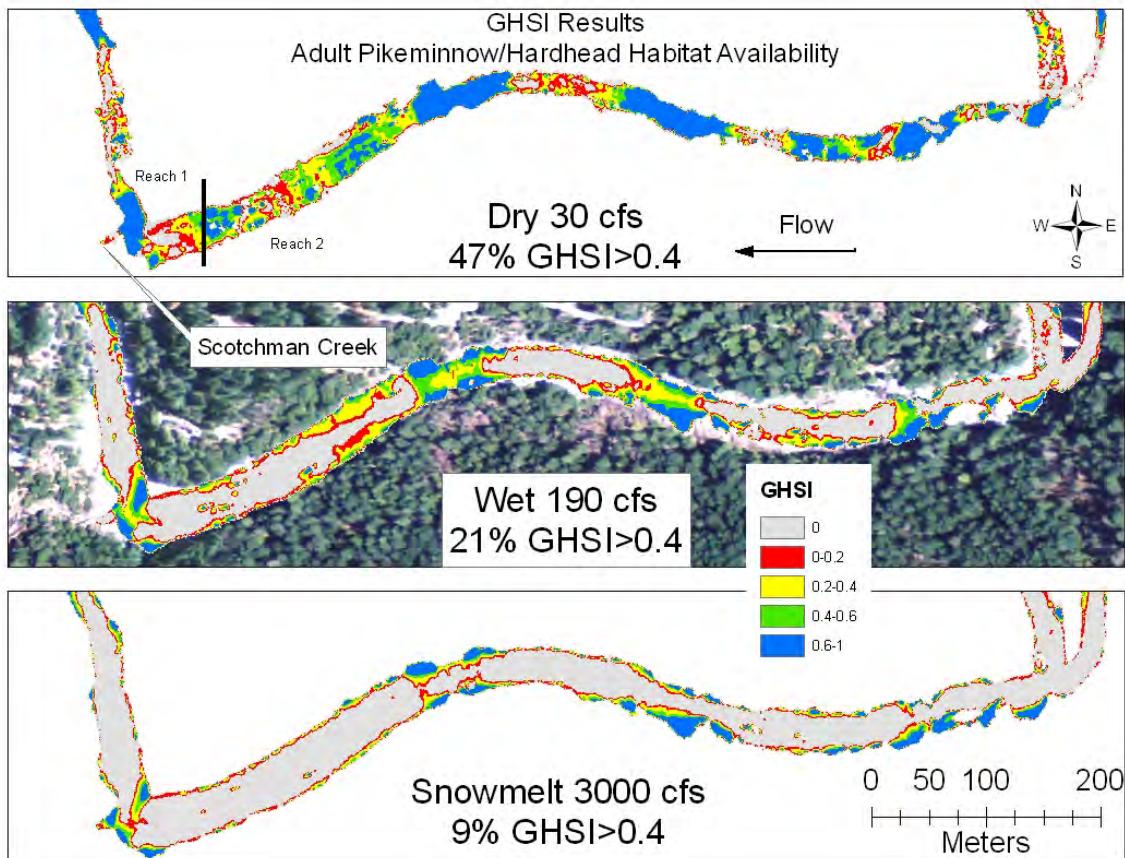


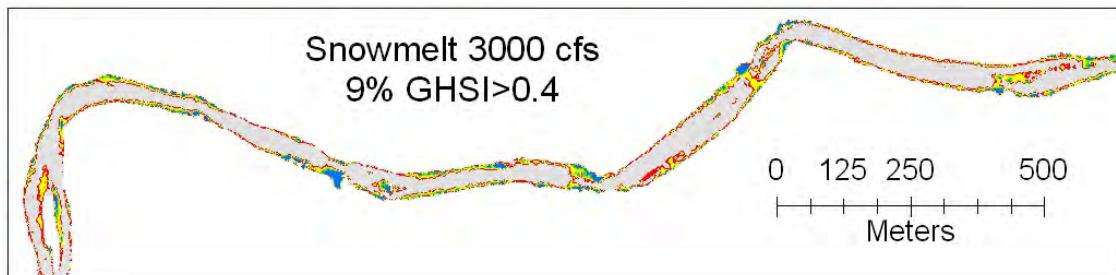
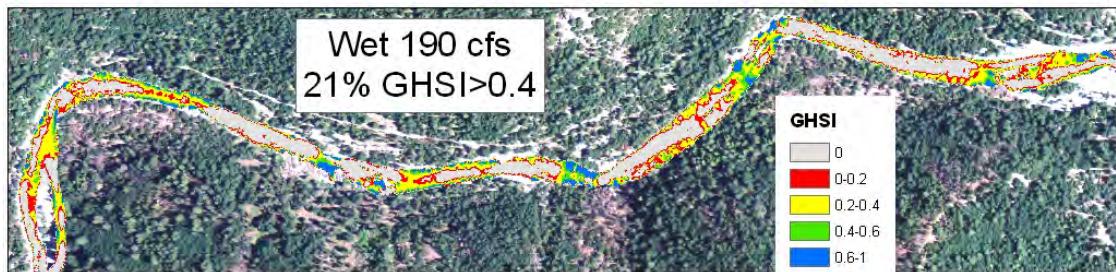
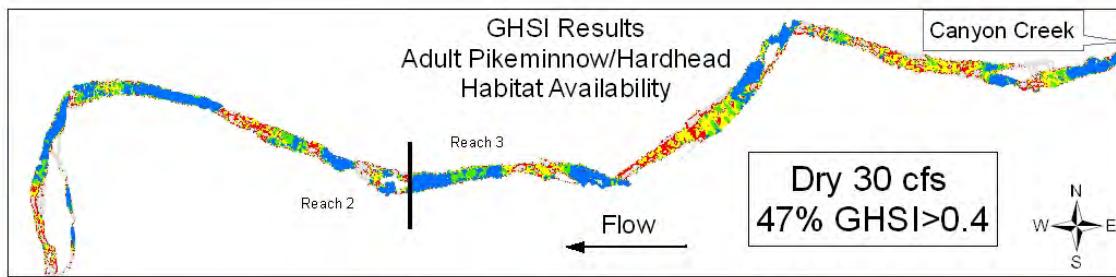


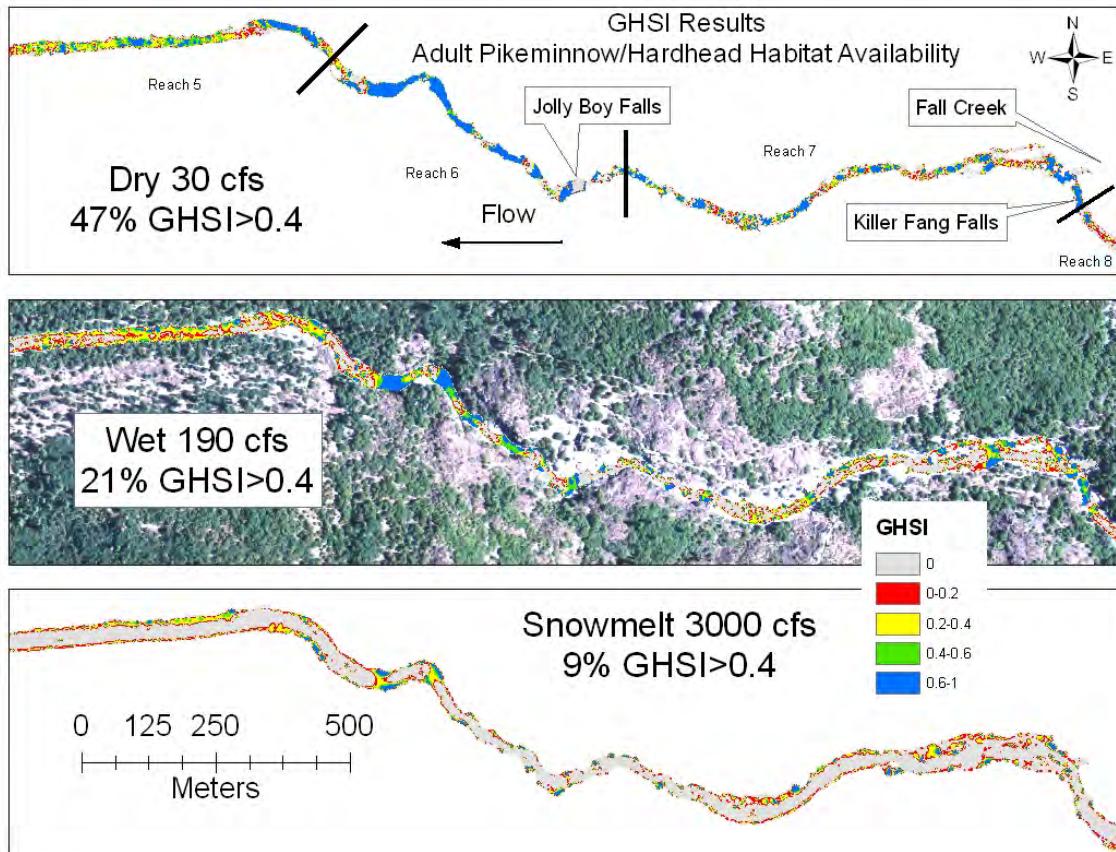


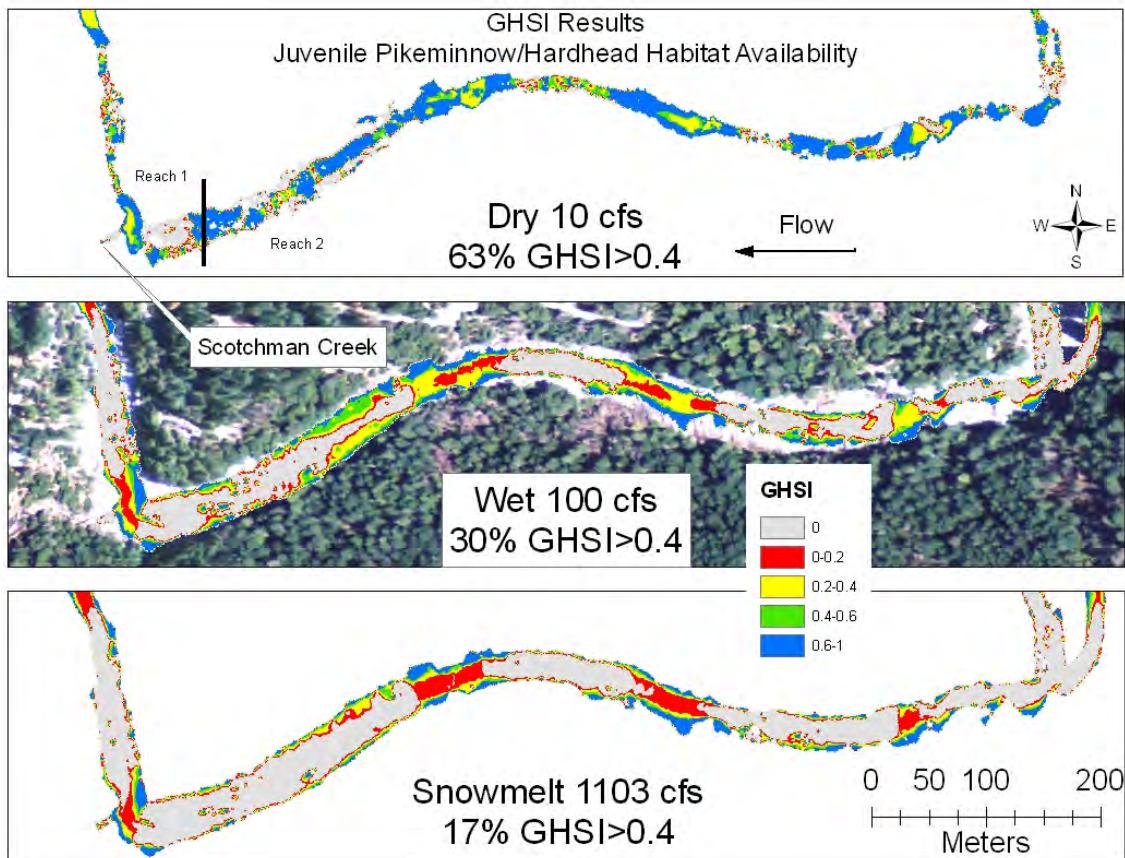


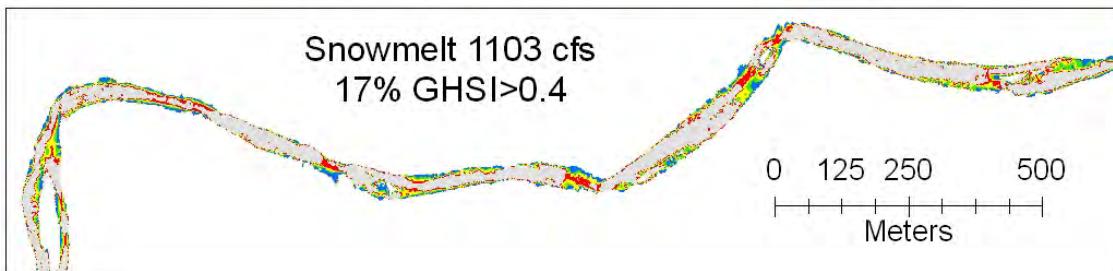
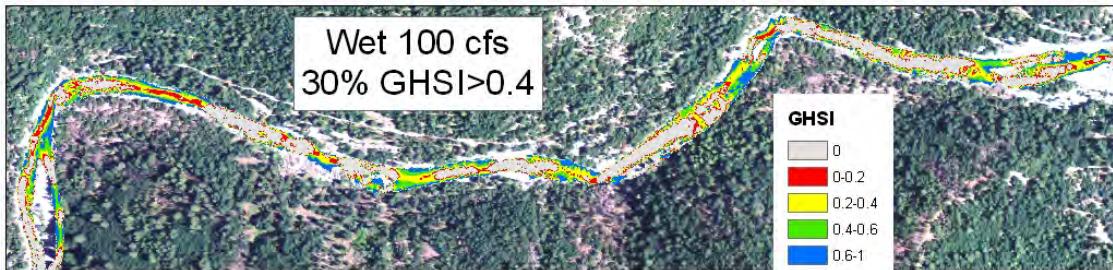
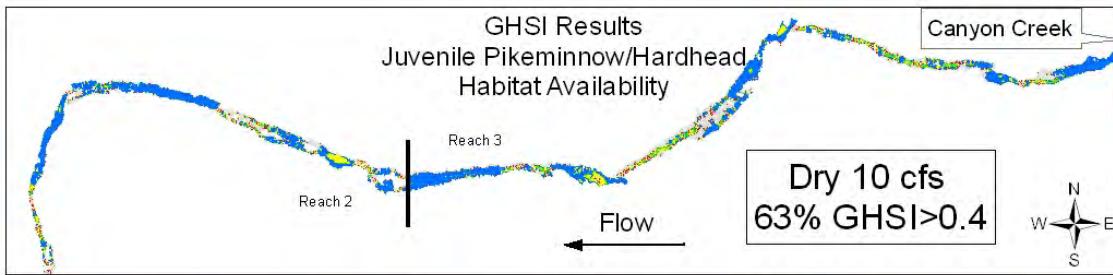


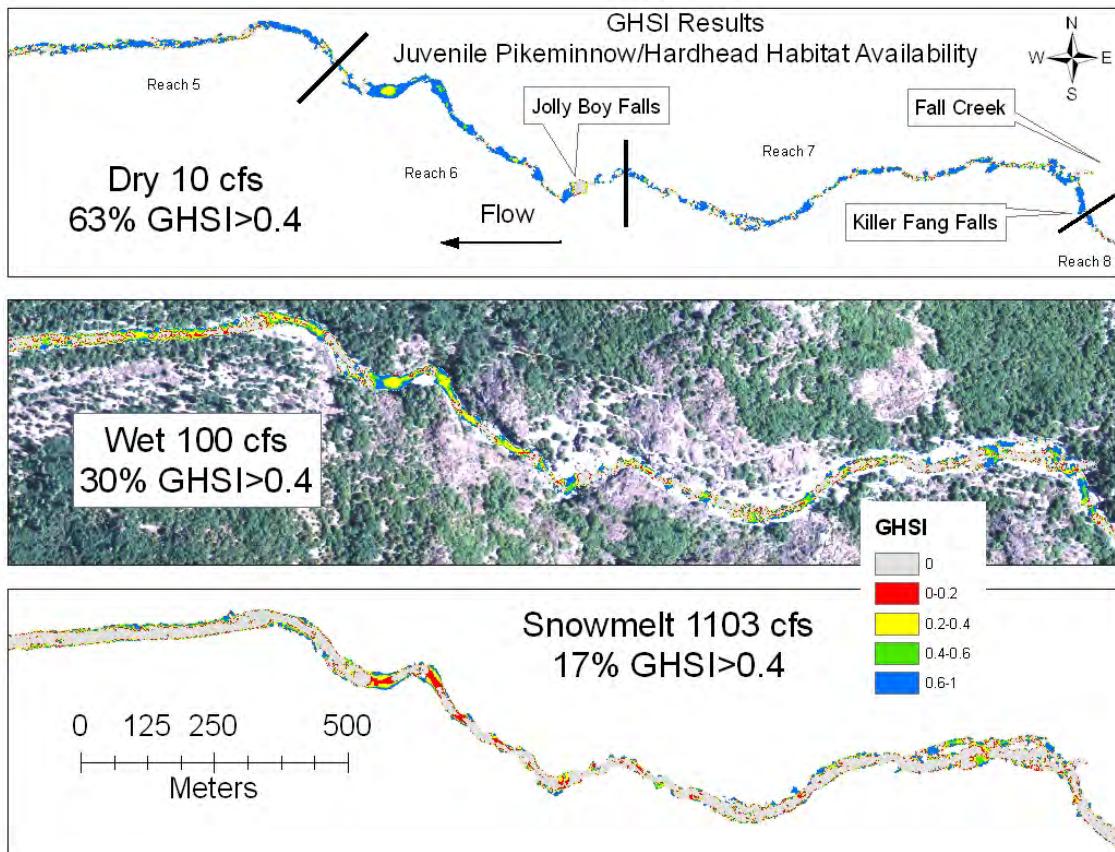












**APPENDIX D:**  
**2D Transect results of percent distribution of GHSI  
binned values by species, lifestage, season, and flow  
release as measured by SYLC gage**

## Appendix D

**2D Transect results of percent distribution of GHSI binned values by species, lifestage, season, and flow release as measured from SYLC gage.**

Percent distribution of GHSI categories using 2D Transects											
		SACRAMENTO SUCKER									
Dry Season	Flow (cfs)	ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	22.8	2.3	1.3	2.0	71.5	39.4	3.3	3.7	3.4	50.3
	10	24.2	2.0	1.9	1.4	70.6	40.1	3.7	3.8	4.1	48.3
	20	24.7	1.7	2.2	1.7	69.7	30.4	2.7	3.0	2.3	61.6
	30	19.7	2.2	2.0	2.3	73.7	19.6	2.0	2.9	2.7	72.8
	45	9.3	1.4	1.5	1.9	85.9	12.5	2.0	2.3	1.9	81.3
RAINBOW TROUT											
	Flow (cfs)	ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	13.0	17.2	22.4	30.4	16.9	38.3	22.3	26.0	8.6	4.9
	10	23.5	17.5	27.3	20.1	11.7	42.0	21.8	25.1	7.3	3.8
	20	37.7	20.2	22.1	11.4	8.6	32.9	23.8	30.2	8.7	4.4
	30	35.9	24.4	16.7	9.9	13.1	23.4	15.8	38.4	12.7	9.6
	45	23.2	27.8	22.7	13.4	12.9	15.5	12.3	31.2	29.2	11.7
PIKEMINNOW / HARDHEAD											
	Flow (cfs)	ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	44.6	7.7	11.2	10.8	25.7	57.7	5.7	12.6	6.1	17.8
	10	45.1	11.7	11.4	14.8	17.0	63.5	7.0	11.0	5.6	13.0
	20	50.0	14.5	12.3	10.3	12.9	57.2	14.7	11.1	4.7	12.4
	30	46.0	14.6	13.3	9.4	16.7	43.8	16.6	14.1	6.6	18.9
	45	32.3	20.0	16.0	9.8	21.9	25.4	16.4	21.0	10.3	26.9

Percent distribution of GHSI categories using 2D Transects

**SACRAMENTO SUCKER**

Dry Season Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

**RAINBOW TROUT**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	20.7	2.4	3.8	3.7	69.5	N/A	N/A	N/A	N/A	N/A
10	18.6	3.0	3.7	3.5	71.2					
20	9.5	1.3	2.9	2.2	84.0					
30	7.0	2.0	1.8	1.7	87.5					
45	4.1	1.8	1.4	1.7	91.0					

**PIKEMINNOW/HARDHEAD**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

Percent distribution of GHSI categories using 2D Transects

**SACRAMENTO SUCKER**

Wet Season Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	26.1	1.4	2.1	1.1	69.2	N/A	N/A	N/A	N/A	N/A
15	24.0	1.8	2.1	1.9	70.2					
30	22.7	2.0	2.3	2.1	70.9					
55	12.8	1.7	2.4	2.1	81.0					
100	7.1	0.8	1.7	1.8	88.6					
190	2.2	0.9	0.7	0.8	95.5					
350	1.2	0.7	0.4	0.5	97.3					

**RAINBOW TROUT**

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	31.4	20.4	24.7	15.2	8.3	38.8	25.8	24.7	7.0	3.6
15	37.9	20.8	21.5	11.1	8.7	32.5	23.9	30.5	8.7	4.4
30	37.6	25.4	14.3	11.8	10.8	26.1	15.8	39.2	10.1	8.8
55	27.4	30.7	16.5	10.9	14.5	18.3	14.1	34.0	25.8	7.8
100	18.5	25.1	29.4	13.0	14.0	12.2	11.6	26.5	35.5	14.2
190	9.0	14.9	28.7	22.6	24.9	7.0	7.0	14.6	35.9	35.6
350	3.6	8.7	13.9	16.4	57.3	2.9	3.2	9.7	19.1	65.1

**PIKEMINNOW/HARDHEAD**

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	47.5	13.0	13.9	12.3	13.3	62.9	9.9	10.6	6.0	10.6
15	50.2	14.3	12.3	10.8	12.4	56.8	14.8	11.5	4.3	12.5
30	46.9	15.7	12.2	9.7	15.4	49.9	13.6	14.4	5.3	16.8
55	38.9	17.3	14.5	10.2	19.1	30.4	21.3	16.5	6.4	25.3
100	25.0	19.6	22.2	12.1	21.0	20.6	15.2	18.6	11.4	34.3
190	9.1	15.0	20.5	16.1	39.3	9.8	9.6	9.9	11.2	59.4
350	3.7	4.7	11.8	11.2	68.7	4.0	4.2	5.7	7.3	78.8

Percent distribution of GHSI categories using 2D Transects

**SACRAMENTO SUCKER**

Wet Season	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
Flow (cfs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5										
15										
30										
55										
100										
190										
350										

**RAINBOW TROUT**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	42.2	9.7	9.1	9.7	29.3
15						42.2	8.8	6.4	8.0	34.5
30						37.6	8.1	8.2	10.1	36.0
55						30.2	12.5	8.8	10.1	38.5
100						26.2	7.1	6.0	8.2	52.4
190						18.5	4.9	4.8	5.6	66.1
350						9.8	3.5	4.9	4.4	77.4

**PIKEMINNOW/HARDHEAD**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15										
30										
55										
100										
190										
350										

Percent distribution of GHSI categories using 2D Transects

**SACRAMENTO SUCKER**

Snowmelt Season Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	25.2	1.9	2.0	1.2	69.8	39.7	3.4	3.8	3.9	49.1
25	25.4	1.7	2.0	1.6	69.3	30.9	2.7	3.4	2.7	60.4
50	22.7	1.8	2.5	2.2	70.7	20.4	2.4	2.5	2.7	71.9
140	13.1	1.9	1.9	2.4	80.6	15.0	2.6	2.7	2.2	77.4
210	22.7	1.9	2.7	2.2	70.6	19.3	2.5	3.1	2.4	72.8
525	7.9	1.4	1.4	1.7	87.7	11.6	1.9	2.2	1.9	82.5
1103	3.5	0.7	0.9	1.2	93.7	4.9	1.4	1.4	1.8	90.5
3000	1.5	0.5	0.7	0.6	96.7	2.1	0.6	1.2	0.5	95.5
6921	1.1	0.5	0.6	0.3	97.5	1.7	0.6	0.7	0.5	96.5

**RAINBOW TROUT**

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	27.4	15.8	27.8	19.1	9.9	42.2	22.3	25.1	7.7	2.8
25	37.2	20.2	22.2	12.1	8.4	33.2	24.7	29.8	8.2	4.0
50	37.2	24.8	14.3	11.8	12.0	25.7	15.8	39.0	10.3	9.2
140	27.9	29.6	17.4	9.9	15.2	18.7	14.5	34.0	24.2	8.6
210	36.3	25.5	13.8	12.1	12.3	24.3	17.0	40.7	9.5	8.4
525	21.2	29.4	26.0	12.2	11.2	15.1	12.3	27.0	35.2	10.3
1103	11.9	17.3	33.9	20.2	16.7	7.1	8.3	19.3	41.8	23.4
3000	3.8	8.2	14.6	18.2	55.1	2.9	4.1	7.4	21.9	63.7
6921	2.9	3.8	8.2	8.1	77.0	2.2	2.4	6.8	10.3	78.3

**PIKEMINNOW/HARDHEAD**

Flow (cfs)	ADULT					JUVENILE				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	46.0	11.7	12.6	14.6	15.0	64.3	6.8	11.8	5.9	11.2
25	50.0	14.6	12.4	10.9	12.2	59.0	13.0	11.4	4.2	12.4
50	47.1	15.3	11.9	9.2	16.5	49.2	13.3	14.3	5.4	17.8
140	39.4	16.7	14.3	10.0	19.6	30.8	23.1	14.2	6.7	25.3
210	46.5	15.2	11.2	9.3	17.7	47.5	13.7	15.7	5.1	18.0
525	31.5	20.9	17.4	10.5	19.7	23.8	17.6	22.4	9.9	26.3
1103	13.1	15.0	29.1	15.0	27.8	11.5	10.4	12.4	13.9	51.7
3000	4.3	5.4	11.8	11.7	66.8	4.1	4.9	4.9	6.0	80.1
6921	2.8	2.6	5.5	7.8	81.3	3.1	2.8	3.5	4.6	86.0

Percent distribution of GHSI categories using 2D Transects

SACRAMENTO SUCKER

Snowmelt Season Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										

RAINBOW TROUT

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	17.5	3.1	3.5	2.8	73.1	40.9	9.6	11.4	11.8	26.3
25	9.3	2.1	2.6	2.3	83.6	43.3	7.9	6.5	9.4	32.9
50	7.3	2.0	1.8	2.0	86.9	36.9	8.6	7.9	10.0	36.6
140	5.9	1.7	1.5	1.8	89.1	29.6	13.8	8.2	10.0	38.3
210	7.2	2.1	2.2	1.8	86.7	37.0	9.5	8.3	9.5	35.6
525	3.0	1.3	1.2	1.2	93.3	28.3	8.0	8.2	8.6	46.9
1103	1.1	0.6	0.5	1.0	96.8	20.9	6.7	5.1	6.9	60.4
3000	0.7	0.3	0.5	0.5	98.1	8.5	3.3	3.6	4.1	80.5
6921	0.8	0.4	0.4	0.3	98.2	8.1	2.7	2.2	3.4	83.6

PIKEMINNOW/HARDHEAD

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										

**APPENDIX E:**  
**1D Model results of percent distribution of GHSI  
binned values by species, lifestage, season, and Ifow  
release as measured from SYLC gage.**

## Appendix E

### 1D Model results of percent distribution of GHSI binned values by species, life stage, season, and flow release as measured from SYLC gage.

Percent distribution of 1D Model GHSI categories											
		SACRAMENTO SUCKER									
Dry Season	Flow (cfs)	ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	11.4	0.0	0.0	0.0	88.6	32.4	0.0	0.0	0.0	67.6
	10	13.3	0.0	0.0	0.0	86.7	28.6	0.0	0.0	0.0	71.4
	20	13.3	0.0	0.0	0.0	86.7	3.8	0.0	0.0	0.0	96.2
	30	6.7	0.0	0.0	0.0	93.3	0.0	0.0	0.0	0.0	100.0
	45	1.0	0.0	0.0	0.0	99.0	0.0	0.0	0.0	0.0	100.0
RAINBOW TROUT											
Flow (cfs)	ADULT					JUVENILE					
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	
	5	21.0	34.3	22.9	10.5	11.4	43.8	29.5	21.9	1.0	3.8
	10	35.2	32.4	27.6	1.9	2.9	36.2	35.2	24.8	1.9	1.9
	20	44.8	33.3	19.0	0.0	2.9	11.4	30.5	42.9	11.4	3.8
	30	27.6	39.0	24.8	2.9	5.7	0.0	17.1	38.1	35.2	9.5
	45	5.7	33.3	42.9	5.7	12.4	0.0	1.0	23.8	55.2	20.0
PIKEMINNOW/HARDHEAD											
Flow (cfs)	ADULT					JUVENILE					
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	
	5	22.9	16.2	26.7	10.5	23.8	61.9	12.4	13.3	1.0	11.4
	10	28.6	29.5	27.6	9.5	4.8	56.2	26.7	8.6	2.9	5.7
	20	34.3	33.3	23.8	4.8	3.8	30.5	29.5	19.0	4.8	16.2
	30	25.7	35.2	27.6	1.9	9.5	10.5	33.3	21.0	4.8	30.5
	45	14.3	21.9	35.2	7.6	21.0	1.9	8.6	24.8	12.4	52.4

Percent distribution of 1D Model GHSI categories

**SACRAMENTO SUCKER**

Dry Season Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

**RAINBOW TROUT**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	2.9	0.0	0.0	0.0	97.1	N/A	N/A	N/A	N/A	N/A
10	0.0	0.0	0.0	0.0	100.0					
20	0.0	0.0	0.0	0.0	100.0					
30	0.0	0.0	0.0	0.0	100.0					
45	0.0	0.0	0.0	0.0	100.0					

**PIKEMINNOW/HARDHEAD**

Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10										
20										
30										
45										

Percent distribution of 1D Model GHSI categories

		SACRAMENTO SUCKER									
Wet Season Flow (cfs)		ADULT			JUVENILE						
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	15.2	0.0	0.0	0.0	84.8	N/A	N/A	N/A	N/A	N/A
	15	13.3	0.0	0.0	0.0	86.7					
	30	7.6	0.0	0.0	0.0	92.4					
	55	1.9	0.0	0.0	0.0	98.1					
	100	0.0	0.0	0.0	0.0	100.0					
	190	0.0	0.0	0.0	0.0	100.0					
	350	0.0	0.0	0.0	0.0	100.0					
		RAINBOW TROUT					JUVENILE				
Flow (cfs)		ADULT			JUVENILE						
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	41.0	32.4	21.0	3.8	1.9	29.5	36.2	30.5	1.0	2.9
	15	43.8	34.3	19.0	0.0	2.9	12.4	28.6	44.8	10.5	3.8
	30	33.3	40.0	18.1	2.9	5.7	0.0	25.7	41.0	24.8	8.6
	55	13.3	29.5	41.9	3.8	11.4	0.0	5.7	27.6	50.5	16.2
	100	0.0	22.9	42.9	18.1	16.2	0.0	0.0	6.7	64.8	28.6
	190	0.0	2.9	25.7	33.3	38.1	0.0	0.0	0.0	41.0	59.0
	350	0.0	0.0	3.8	18.1	78.1	0.0	0.0	0.0	7.6	92.4
		PIKEMINNOW/HARDHEAD					JUVENILE				
Flow (cfs)		ADULT			JUVENILE						
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	5	31.4	32.4	25.7	5.7	4.8	49.5	26.7	11.4	6.7	5.7
	15	34.3	32.4	23.8	5.7	3.8	30.5	29.5	20.0	3.8	16.2
	30	30.5	33.3	24.8	2.9	8.6	12.4	34.3	19.0	7.6	26.7
	55	16.2	28.6	31.4	6.7	17.1	2.9	12.4	29.5	7.6	47.6
	100	11.4	14.3	36.2	8.6	29.5	0.0	3.8	16.2	10.5	69.5
	190	1.0	7.6	20.0	11.4	60.0	0.0	0.0	2.9	6.7	90.5
	350	0.0	0.0	2.9	3.8	93.3	0.0	0.0	0.0	1.0	99.0

Percent distribution of 1D Model GHSI categories										
SACRAMENTO SUCKER										
Wet Season	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
Flow (cfs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5										
15										
30										
55										
100										
190										
350										
RAINBOW TROUT										
Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	76.2	1.9	1.0	2.9	18.1
15						56.2	14.3	2.9	1.9	24.8
30						29.5	16.2	10.5	5.7	38.1
55						15.2	7.6	4.8	3.8	68.6
100						1.0	1.9	5.7	2.9	88.6
190						0.0	1.0	0.0	1.9	97.1
350						0.0	0.0	0.0	0.0	100.0
PIKEMINNOW/HARDHEAD										
Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15										
30										
55										
100										
190										
350										

Percent distribution of 1D Model GHSI categories											
		SACRAMENTO SUCKER									
Snowmelt Season	Flow (cfs)	ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	10	15.2	0.0	0.0	0.0	84.8	27.6	0.0	0.0	0.0	72.4
	25	12.4	0.0	0.0	1.0	86.7	3.8	0.0	0.0	0.0	96.2
	50	7.6	0.0	0.0	0.0	92.4	0.0	0.0	0.0	0.0	100.0
	140	1.9	1.0	0.0	0.0	97.1	0.0	0.0	0.0	0.0	100.0
	210	6.7	0.0	0.0	0.0	93.3	0.0	0.0	0.0	0.0	100.0
	525	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
	1103	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
	3000	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
	6921	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
RAINBOW TROUT											
Flow (cfs)		ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	10	36.2	34.3	24.8	1.9	2.9	35.2	32.4	28.6	1.9	1.9
	25	44.8	32.4	20.0	0.0	2.9	13.3	30.5	44.8	7.6	3.8
	50	32.4	40.0	19.0	2.9	5.7	0.0	18.1	47.6	24.8	9.5
	140	9.5	38.1	39.0	4.8	8.6	0.0	0.0	31.4	54.3	14.3
	210	24.8	37.1	28.6	3.8	5.7	0.0	3.8	46.7	39.0	10.5
	525	0.0	17.1	50.5	13.3	19.0	0.0	0.0	4.8	63.8	31.4
	1103	0.0	1.0	19.0	36.2	43.8	0.0	0.0	1.0	38.1	61.0
	3000	0.0	0.0	1.0	7.6	91.4	0.0	0.0	0.0	1.9	98.1
	6921	0.0	0.0	0.0	1.0	99.0	0.0	0.0	0.0	0.0	100.0
PIKEMINNOW/HARDHEAD											
Flow (cfs)		ADULT					JUVENILE				
		0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
	10	28.6	28.6	31.4	6.7	4.8	54.3	26.7	11.4	1.9	5.7
	25	33.3	34.3	26.7	1.9	3.8	32.4	30.5	16.2	6.7	14.3
	50	30.5	30.5	28.6	1.0	9.5	11.4	33.3	20.0	7.6	27.6
	140	18.1	23.8	34.3	8.6	15.2	2.9	13.3	27.6	8.6	47.6
	210	27.6	24.8	31.4	5.7	10.5	8.6	22.9	24.8	8.6	35.2
	525	11.4	14.3	34.3	7.6	32.4	0.0	4.8	17.1	7.6	70.5
	1103	1.0	7.6	19.0	10.5	61.9	0.0	0.0	0.0	11.4	88.6
	3000	0.0	0.0	1.0	0.0	99.0	0.0	0.0	0.0	0.0	100.0
	6921	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0

SACRAMENTO SUCKER										
Snowmelt Season	FRY					SPAWN				
Flow (cfs)	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										
RAINBOW TROUT										
Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	0.0	0.0	0.0	0.0	100.0	78.1	1.9	2.9	1.0	16.2
25	0.0	0.0	0.0	0.0	100.0	61.0	11.4	2.9	1.9	22.9
50	0.0	0.0	0.0	0.0	100.0	26.7	16.2	11.4	4.8	41.0
140	0.0	0.0	0.0	0.0	100.0	3.8	12.4	7.6	2.9	73.3
210	0.0	0.0	0.0	0.0	100.0	10.5	16.2	12.4	7.6	53.3
525	0.0	0.0	0.0	0.0	100.0	0.0	1.0	2.9	1.9	94.3
1103	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
3000	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
6921	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
PIKEMINNOW/HARDHEAD										
Flow (cfs)	FRY					SPAWN				
	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0	0.6-1	0.4-0.6	0.2-0.4	0-0.2	0
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25										
50										
140										
210										
525										
1103										
3000										
6921										